CDM

U.S. Army Corps of Engineers

New England District

Assabet River Sediment Management Plan

December 2008

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Section 1
Introduction

1.1 Project Background

Under previous efforts, CDM conducted data collection, modeling and analysis tasks to assess alternatives such as sediment and/or dam removal for 6 dams on the mainstem of the Assabet River in MA. The modeling efforts included evaluating changes in water surface, downstream movement of sediment behind each dam, and changes in water quality due to changes in sediment phosphorus release rates and hydraulic changes for various sediment and dam removal alternatives. One of the results of the effort suggests that the most beneficial water quality improvements to the Assabet River can be achieved through dam removal.

If any of the Assabet River dams were to be removed, as part of the dam removal, existing sediment would also need to be considered and managed to lessen sediment transport downstream.

1.2 Relevant Policies and Regulations

A review of relevant policies and regulations was conducted, including MassDEP's, *Dam Removal and the Wetland Regulations (December 2007)* and *314 CMR 9.00: 401 Water Quality Certification for Discharge of Dredged or Fill Material, Dredging, and Dredged Material Disposal in Waters of the United States within the Commonwealth*. In the *Dam Removal and the Wetland Regulations* guidance document, MassDEP provides procedural guidance on sediment management and transport from dam removal projects. Requirements of a sampling and analysis plan are identified based on the results of relevant existing data, if available and a "due diligence" review. Sediment sampling and analysis will likely be required by MassDEP if the sediment is fine-grained or if there is potential for sediment contamination. The following criteria will be considered in future decisions regarding sediment sampling and analysis:

1. Due Diligence Review of past and present land use practices in the watershed, upstream of the dam, to determine the potential for sediment contamination. This criterion is met if there is no potential for sediment contamination.

2. Sieve Analysis to determine if the sediment to be dredged contains less than 10% by weight of particles passing the No. 200 U.S. Standard Series Testing Sieve. This criterion is met if the sediment to be dredged contains *less than* 10% fine-grained sediment.

1.3 Plan Overview

This document presents a sediment management plan for the future phases of the Assabet River dam removal project. An overview of existing data is presented (Section 2), followed by a summary of proposed sampling and analysis (Section 3) that could be conducted as part of future phases of this study. Considerations for sediment management are discussed (Section 4) followed by a recommended sediment management plan that could be implemented as part of future phases of this study.

Section 2
Existing Data

2.1 Available Data Sources

A review of existing data was conducted including data from the following sources:

- Zimmerman and Sorenson, 2005, *"Sediment studies in the Assabet River, Central Massachusetts, 2003: U.S. Geological Survey Scientific Investigations Report 2005-5131"*. (data and sampling sites included as Attachments 1 and 2)

- Normandeau Associates, February 2007, Technical Memorandum to CDM: *"River Cross Section and Sediment Data Collection Field Investigation"*.

- CDM, February 13, 2008, Technical Memorandum to USACE, *"Assabet River Sediment and Dam Removal Study, Task 15 Sediment Removal Quantities"*. (included as Attachment 3)

2.2 Analysis of Existing Data

2.2.1 Dredging Extents and Volumes (Planning-level)

The sediment removal quantities associated with dam removal for the six study dams were calculated based on the results of the HEC-6 modeling conducted previously by CDM. A constant slope methodology was applied to the modeling results which, in general, allows for estimation of the sediment quantity that would be transported downstream in a relatively short period of time following dam removal. The determination of dredging extents and volumes is discussed in more depth in the February 13, 2008 CDM Memorandum: Assabet River Sediment and Dam Removal Study, Task 15 Sediment Removal Quantities.

It should be noted that for the purposes of this planning-level estimate, the total sediment removal volumes listed in Table 2-1 include only the sediment to be dredged within the extent of the impoundment (see February 13, 2008 Memorandum). Due to the large amount of sediment accumulated behind the Aluminum City dam, the actual required dredging would need to extend past the boundary of the impoundment in order to achieve stability in the streambed upstream, thus increasing the total removal volume significantly. At this stage of planning, the Aluminum City impoundment is the only known case where the dredging area may need to extend past the boundary of the impoundment.

Table 2-1 lists the estimated sediment volume to be dredged for each impoundment. Figures 2-1 to 2-6, provided at the end of Section 2, show the dredging extents for each of the six impoundments.

Table 2-1: Estimated Sediment Volumes to be Dredged

Impoundment	Volume to be Dredged* (yd^3)
Aluminum City	1,300
Allen Street	2,230
Hudson	71,560
Gleasondale	27,860
Ben Smith	67,600
Powdermill	65,830

* CDM, Memorandum: *Assabet River Sediment and Dam Removal Study, Task 15 Sediment Removal Quantities, February 13, 2008*

2.2.2 Review of MassDEP Listed Sites

An initial review of past and present land use practices in the watershed was conducted, to determine the potential for sediment contamination. This review was conducted for the upstream vicinity of the impoundment for each of the 6 dams. The initial review indicated that there is limited potential for contamination. There are several sites included in the MassDEP's database where a release or threat of release has been reported in accordance with 310 CMR 40.0300, for which additional information needs to be obtained as part of future efforts.

2.2.3 Existing Sieve Analysis Data

A summary of the results of sieve analyses completed in February 2007 is presented in Table 2-2. Sediment samples were taken from along the Assabet River mainstem and impounded areas for the entire study reach. As presented in Table 2-2, all but one site along the Assabet River mainstem has greater than 10% fine-grained sediments. Note that of the samples collected downstream of a dam location, this sample was the only sample that was collected with a bucket auger rather than a hand-driven piston core unit. The sample (which was collected downstream of the Ben Smith dam) was collected with a bucket auger due to the presence of cobbles and gravel in the subsurface. It is likely however, that any sediment removed from the Ben Smith impoundment will have greater than 10% fine-grained sediment.

Table 2-2: Summary of Percent Fine-Grained Sediment
(Normandeau Associates, Inc., February 2007)

Site	Sample Location	Sample Depth (inches)	% Fines by Weight *Passing #200 Sieve (0.075mm)*
S1-GA	Downstream of Aluminum City Dam	10.5 – 13.5	24.8
S2-GA	Downstream of Allen Street Dam	10.5 – 13.5	54.9
S3-A	Downstream of Route 85 Dam in Hudson	10.5 – 13.5	17.8
S4-A	Downstream of Gleasondale Dam	10.5 – 13.5	74.4
S5-A	Downstream of Ben Smith Dam	10.5 – 13.5	7.9
S6-A	Downstream of Powdermill Dam	10.5 – 13.5	35.2
3A	Allen Street Impoundment	0 – 7.9	62.3
4A	Allen Street Impoundment	0 – 7.9	70.9
5A	Aluminum City Impoundment	0 – 16.3	42.0
8A	Aluminum City Impoundment	0 – 7.9	53.5
10A	Hudson Impoundment	0 – 9.1	46.5
15A	Hudson Impoundment	0 – 7.9	63.1
19A	Ben Smith Impoundment	0 – 9.4	80.8
28A	Ben Smith Impoundment	0 – 8.7	69.2
36A	Gleasondale Impoundment	0 – 7.9	15.9
38A	Gleasondale Impoundment	0 – 8.7	36.8
51A	Powdermill Impoundment	0 – 7.9	43.8
52A	Powdermill Impoundment	0 – 7.9	33.3

2.2.4 Existing Sediment Core Data (USGS, 2003)

In 2003, the USGS conducted a comprehensive survey of sediment distribution and chemistry from six impoundments along the Assabet River. Sediment thickness and water depth were manually measured using a stainless steel rod at 682 locations.

In addition, approximately 180 sediment cores were collected at 57 sampling sites within the six impoundments to assess sediment chemistry (see Attachments 1 and 2). The cores were analyzed for metals, reactive sulfide, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), organochlorine pesticides, and extractable petroleum hydrocarbons (EPH). However, the analyses of VOCs were inconclusive due to matrix interference at the laboratory and results were not reported. The metals that were analyzed included those typically considered for sediment characterization studies with the exception of mercury which was not analyzed due to the storage and analysis requirements.

The Massachusetts Contingency Plan (MCP) does not have notification thresholds for contaminants in sediment. However, dredged material, including sediment, placed at an upland location is subject to the release notification requirements and thresholds of 310 CMR 40.0300 and 40.1600 for soil, unless such placement is in accordance with an approval, permit or certification issued by the Department. MassDEP has established limits for specific contaminants that are acceptable for sediment reuse at Massachusetts landfills. Note that there are other acceptance criteria and/or MassDEP approval that may be required prior to disposal. For purposes of evaluating potential sediment disposal options, existing sediment core data for each impoundment was compared with the thresholds listed in 310 CMR 40.1600 MCP Reporting Category RCS-1 for upland placement, and the limits for reuse at an in-state lined landfill. If the reuse limits are exceeded, then the sediment may have to be disposed of at an out-of-state landfill. Sediment that meets the criteria of a hazardous waste will require disposal at a RCRA Subtitle C landfill. The reporting category RCS-1 is the more stringent category applied to soil samples obtained at or within 500 ft of a residential dwelling, a residentially-zoned property, school, playground, recreational area, or park.

The following subsections discuss the results of the USGS analysis for the six individual impoundments. Tabulated data and figures that show the sample identifications from the USGS study are provided as Attachment 2.

2.2.4.1 Aluminum City Impoundment

Of the 185 sediment core samples, 10 samples were taken within the Aluminum City impoundment. Sediment cores were taken at 4 locations with sampling depths ranging from 6.7 to 23.2 inches and a median depth of 10.4 inches.

The results of the sediment chemical analyses for the Aluminum City impoundment are summarized in Table 2-3.

Table 2-3: Summary of USGS (2003) Sediment Data for the Aluminum City Impoundment and Comparison to Reuse and Disposal Thresholds

Parameter	No. of Samples	Median	Maximum	310 CMR 40.1600 MCP Reportable Concentrations Soil Category RCS-1	Reuse at In-State Lined Landfill
Arsenic	10	9	16	20	40
Cadmium	10	2	4	2	80
Chromium	10	149	2,070	30	1,000
Copper	10	297.5	844	1,000	*
Lead	10	81.5	238	300	2,000
Nickel	10	24	31	20	*
Zinc	10	285	1,220	2,500	*
Total PCBs	6	0.27	0.5	2	< 2
Total PAHs	6	3	6	100	100
EPH	6	49.5	61	1,000	5,000
Total VOCs**	N/A	N/A	N/A	*	10

All units in mg/kg, dry weight.
* No threshold
** VOCs not reported due to matrix interference during analysis
Highlighted: Concentrations reported above RCS-1 and/or landfill reuse criteria

In the Aluminum City impoundment, sample cores AC1 through AC4 are located within the area proposed for dredging. Concentrations of cadmium, chromium, and nickel were found above the RCS-1 threshold criteria based on information contained in the USGS 2003 sampling study. Chromium was the only compound found above the landfill reuse criteria of 1,000 mg/kg at location AC4 at a concentration of 2,070 mg/kg. The organic compound levels were below the RCS-1 and landfill reuse criteria.

2.2.4.2 Allen Street Impoundment

Of the 185 sediment core samples, 16 samples were taken within the Allen Street impoundment. Sediment cores were taken at 4 locations with sampling depths ranging from 7.9 to 56.7 inches and a median depth of 17.4 inches.

The results of the sediment chemical analyses for the Allen Street impoundment are summarized in Table 2-4.

Table 2-4: Summary of USGS (2003) Sediment Data for the Allen Street Impoundment and Comparison to Reuse and Disposal Thresholds

Parameter	No. of Samples	Median	Maximum	310 CMR 40.1600 MCP Reportable Concentrations Soil Category RCS-1	Reuse at In-State Lined Landfill
Arsenic	16	11	16	20	40
Cadmium	16	1	4	2	80
Chromium	16	154	340	30	1,000
Copper	16	55	807	1,000	*
Lead	16	150	241	300	2,000
Nickel	16	19	33	20	*
Zinc	16	216	827	2,500	*
Total PCBs	6	0.21	0.33	2	< 2
Total PAHs	6	12	58	100	100
EPH	6	74.5	148	1,000	5,000
Total VOCs**	N/A	N/A	N/A	*	10

All units in mg/kg, dry weight.
* *No threshold*
*** VOCs not reported due to matrix interference during analysis*
Highlighted: Concentrations reported above RCS-1 and/or landfill reuse criteria

In the Allen Street impoundment, sample cores AS5 through AS8 are located within the area proposed for dredging. Concentrations of cadmium, chromium, and nickel were found above the RCS-1 threshold criteria based on information contained in the USGS 2003 sampling study. No metals or organic compounds were found above the landfill reuse criteria.

2.2.4.3 Hudson Impoundment

Of the 185 sediment core samples, 23 samples were taken within the Hudson impoundment. Sediment cores were taken at 7 locations with sampling depths ranging from 7.1 to 39.4 inches and a median depth of 13.6 inches.

The results of the sediment chemical analyses for the Hudson impoundment are summarized in Table 2-5.

Table 2-5: Summary of USGS (2003) Sediment Data for the Hudson Impoundment and Comparison to Reuse and Disposal Thresholds

Parameter	No. of Samples	Median	Maximum	310 CMR 40.1600 MCP Reportable Concentrations Soil Category RCS-1	Reuse at In-State Lined Landfill
Arsenic	23	9	101	20	40
Cadmium	23	<1	3	2	80
Chromium	23	155	304	30	1,000
Copper	23	14	141	1,000	*
Lead	23	20	324	300	2,000
Nickel	23	22	86	20	*
Zinc	23	63	422	2,500	*
Total PCBs	14	ND	ND	2	< 2
Total PAHs	14	7	77	100	100
EPH	10	34	47	1,000	5,000
Total VOCs**	N/A	N/A	N/A	*	10

All units in mg/kg, dry weight.
** No threshold*
*** VOCs not reported due to matrix interference during analysis*
ND: not detected
Highlighted: Concentrations reported above RCS-1 and/or landfill reuse criteria

In the Hudson impoundment, sample cores H12 through H15 are located within the area proposed for dredging. Concentrations of arsenic, cadmium, chromium, lead, and nickel were found above the RCS-1 threshold criteria based on information contained in the USGS 2003 sampling study. Arsenic was the only compound found above the landfill reuse criteria of 40 mg/kg at location H15 at a concentration of 101 mg/kg. The organic compound levels were below the RCS-1 and landfill reuse criteria. The full extent of the Hudson impoundment showed similar results.

2.2.4.4 Gleasondale Impoundment

Of the 185 sediment core samples, 37 samples were taken within the Gleasondale impoundment. Sediment cores were taken at 12 locations with sampling depths ranging from 5.9 to 77.2 inches and a median depth of 15.4 inches.

The results of the sediment chemical analyses for the Gleasondale impoundment are summarized in Table 2-6.

Table 2-6: Summary of USGS (2003) Sediment Data for the Gleasondale Impoundment and Comparison to Reuse and Disposal Thresholds

Parameter	No. of Samples	Median	Maximum	310 CMR 40.1600 MCP Reportable Concentrations Soil Category RCS-1	Reuse at In-State Lined Landfill
Arsenic	37	9	75	20	40
Cadmium	37	<1	12	2	80
Chromium	37	194	409	30	1,000
Copper	37	11	405	1,000	*
Lead	37	16	254	300	2,000
Nickel	37	17	149	20	*
Zinc	37	37	518	2,500	*
Total PCBs	18	0.48	3	2	< 2
Total PAHs	18	3	99	100	100
EPH	16	53.5	264	1,000	5,000
Total VOCs**	N/A	N/A	N/A	*	10

All units in mg/kg, dry weight.
**   No threshold*
*** VOCs not reported due to matrix interference during analysis*
Highlighted: Concentrations reported above RCS-1 and/or landfill reuse criteria

In the Gleasondale impoundment, sample cores G18, G20-G22, and G24-G26 are located within the area proposed for dredging. Concentrations of arsenic, cadmium, chromium, and nickel were found above the RCS-1 threshold criteria based on information contained in the USGS 2003 sampling study. Arsenic was the only metal found above the landfill criteria of 40 mg/kg at locations G18 and G20 within the area to be dredged and at location G19 outside the area to be dredged. PCBs were also found above the RCS-1 and landfill criteria of 2 mg/kg at location G18 at a concentration of 3.1 mg/kg.

2.2.4.5 Ben Smith Impoundment

Of the 185 sediment core samples, 61 samples were taken within the Ben Smith impoundment. Sediment cores were taken at 18 locations with sampling depths ranging from 9 to 74 inches and a median depth of 13 inches.

The results of the sediment chemical analyses for the Ben Smith impoundment are summarized in Table 2-7.

Table 2-7: Summary of USGS (2003) Sediment Data for the Ben Smith Impoundment and Comparison to Reuse and Disposal Thresholds

Parameter	No. of Samples	Median	Maximum	310 CMR 40.1600 MCP Reportable Concentrations Soil Category RCS-1	Reuse at In-State Lined Landfill
Arsenic	61	11	83	20	40
Cadmium	61	<1	7	2	80
Chromium	61	170	397	30	1,000
Copper	61	13	318	1,000	*
Lead	61	16	3,800	300	2,000
Nickel	61	19	132	20	*
Zinc	61	37	637	2,500	*
Total PCBs	31	0.33	1.6	2	< 2
Total PAHs	31	1.2	31	100	100
EPH	28	55.5	166	1,000	5,000
Total VOCs**	N/A	N/A	N/A	*	10

All units in mg/kg, dry weight.
* *No threshold*
*** VOCs not reported due to matrix interference during analysis*
Highlighted: Concentrations reported above RCS-1 and/or landfill reuse criteria

In the Ben Smith impoundment, sample cores BS41 through BS45 are located within the area proposed for dredging. Concentrations of arsenic, cadmium, chromium, lead, and nickel were found above the RCS-1 threshold criteria based on information contained in the USGS 2003 sampling study. Arsenic was found above the landfill reuse criteria of 40 mg/kg at location BS41 at a concentration of 83 mg/kg and slightly above at location BS43 at a concentration of 41 mg/kg. Lead was also detected at a maximum concentration above the landfill reuse threshold. The organic compound levels were below the RCS-1 and landfill reuse criteria.

The full extent of the Ben Smith impoundment showed similar results. Lead was found above the RCS-1 and landfill reuse threshold criteria at location BS38. The concentrations of lead primarily at this location as well as chromium at most locations are above the theoretical concentration at which the toxicity characteristic leaching procedure (TCLP) criteria may also be exceeded. Although outside of the area proposed for dredging, additional samples are recommended for this area as discussed in the next section.

2.2.4.5 Powdermill Impoundment

Of the 185 sediment core samples, 37 samples were taken within the Powdermill impoundment. Sediment cores were taken at 12 locations with sampling depths ranging from 7.1 to 39.4 inches and a median depth of 13.6 inches.

The results of the sediment chemical analyses for the Powdermill impoundment are summarized in Table 2-8.

Table 2-8: Summary of USGS (2003) Sediment Data for the Powdermill Impoundment and Comparison to Reuse and Disposal Thresholds

Parameter	No. of Samples	Median	Maximum	310 CMR 40.1600 MCP Reportable Concentrations Soil Category RCS-1	Reuse at In-State Lined Landfill
Arsenic	37	15	101	20	40
Cadmium	37	<1	10	2	80
Chromium	37	311	2,270	30	1,000
Copper	37	78	3,430	1,000	*
Lead	37	167	1,250	300	2,000
Nickel	37	30	272	20	*
Zinc	37	163	1,200	2,500	*
Total PCBs	22	0.39	1.3	2	< 2
Total PAHs	22	17	1,100	100	100
EPH	20	81.5	438	1,000	5,000
Total VOCs**	N/A	N/A	N/A	*	10

All units in mg/kg, dry weight.
** No threshold*
*** VOCs not reported due to matrix interference during analysis*
Highlighted: Concentrations reported above RCS-1 and/or landfill reuse criteria

In the Powdermill impoundment, sample cores P46-P50, P52, and P55-P57 are located within the area proposed for dredging. Concentrations of arsenic, cadmium, chromium, copper, lead and nickel were found above the RCS-1 threshold criteria based on information contained in the USGS 2003 sampling study. Sample P54 was the only sample taken during the study to exceed the RCS-1 criterion for copper (1,000 mg/kg) at a concentration of 3,430 mg/kg. Total PAHs were also found above the RCS-1/landfill criteria of 100 mg/kg at P50 (1,100 mg/kg) and P52 (180 mg/kg). Arsenic was found to be above the landfill criteria of 40 mg/kg at several locations, at concentrations up to 101 mg/kg. Chromium was found to exceed the landfill criteria of 1,000 mg/kg at several locations, at concentrations up to 2,270 mg/kg.

The following table summarizes the data in the preceding tables, comparing the RCS-1 and landfill reuse exceedances for the six impoundments.

Table 2-9: Summary of RCS-1 and Landfill Reuse Exceedances (USGS, 2003)

Impoundment	Soil Category RCS-1 Exceedances*	In-State Landfill Reuse Exceedances
Aluminum City	Cadmium, Chromium, Nickel	Chromium
Allen Street	Cadmium, Chromium, Nickel	-
Hudson	Arsenic, Cadmium, Chromium, Lead, Nickel	Arsenic
Gleasondale	Arsenic, Cadmium, Chromium, Nickel, PCBs	Arsenic, PCBs
Ben Smith	Arsenic, Cadmium, Chromium, Lead, Nickel	Arsenic, Lead
Powdermill	Arsenic, Cadmium, Chromium, Lead, Copper, Nickel, PAHs	Arsenic, Chromium, PAHs

**310 CMR 40.1600 MCP Reportable Concentrations Soil Category RCS-1*

2.2.5 Additional Data Needs

Based on the results of the initial review of existing data, including sediment core data summarized above, the MassDEP listed sites, and sediment sieve analysis data, it is concluded that MassDEP will likely require chemical and physical testing of sediments that may be exposed, dredged, or mobilized as a result of removing any of the Assabet River dams.

Figure 2-1: Dredging Extents for Aluminum City Impoundment

Assabet River

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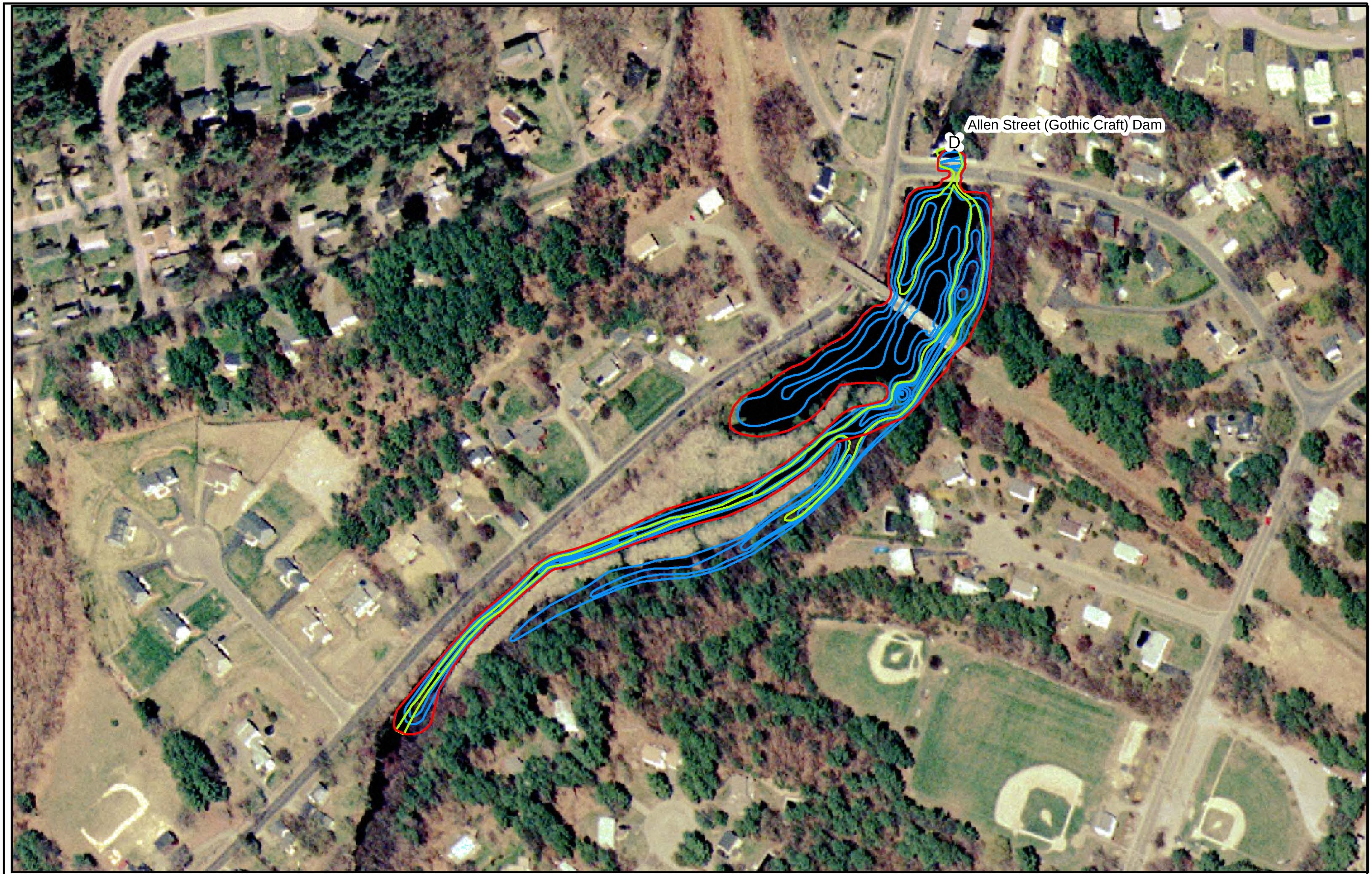

Figure 2-2: Dredging Extents for Allen Street Impoundment

Assabet River

CDM

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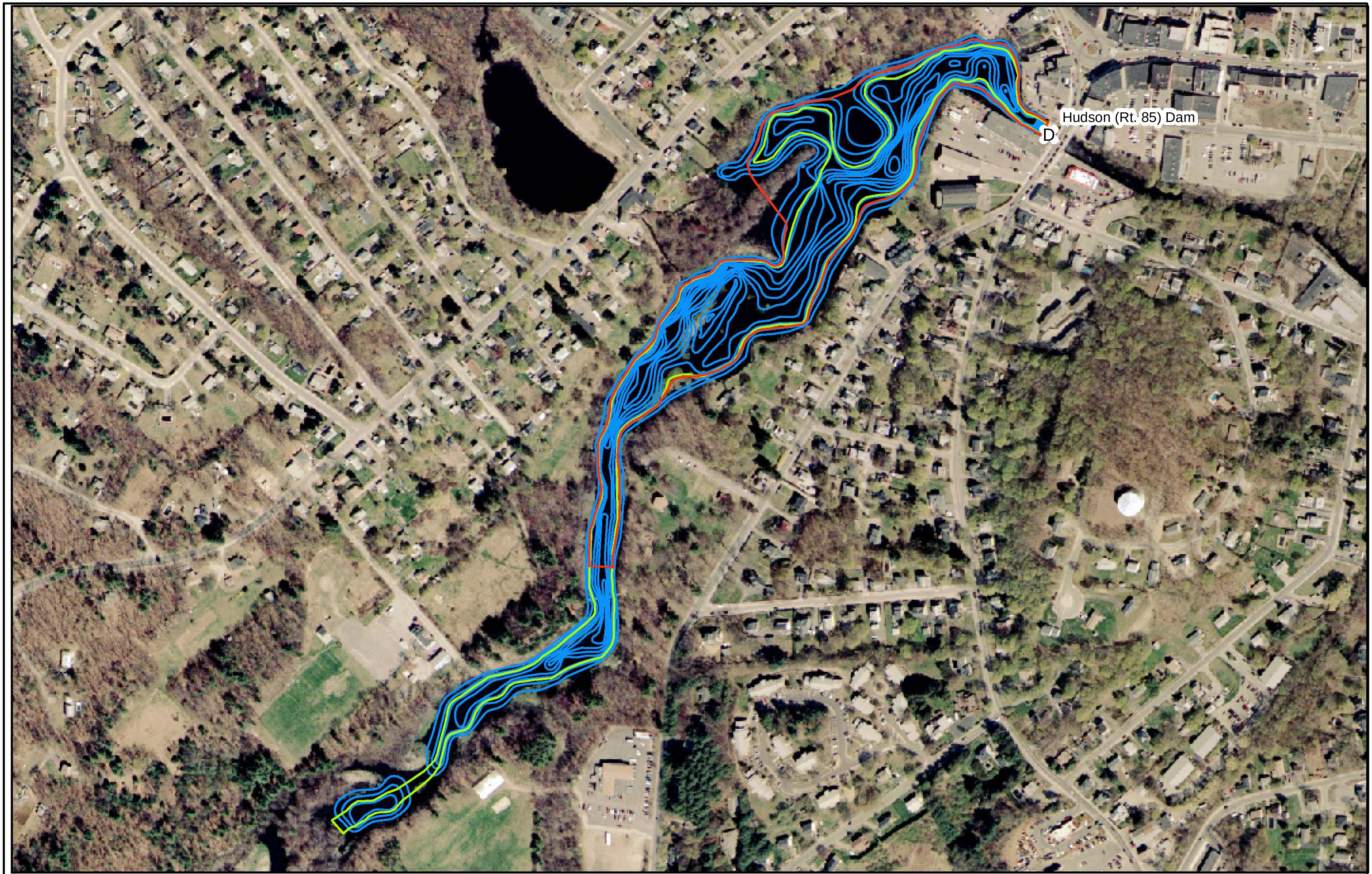

Figure 2-3: Dredging Extents for Hudson Impoundment

Assabet River

Future Water Level

Dredging Boundary

1-ft Bathymetric Contours

0 100 200 400 Yards

5/23/2008

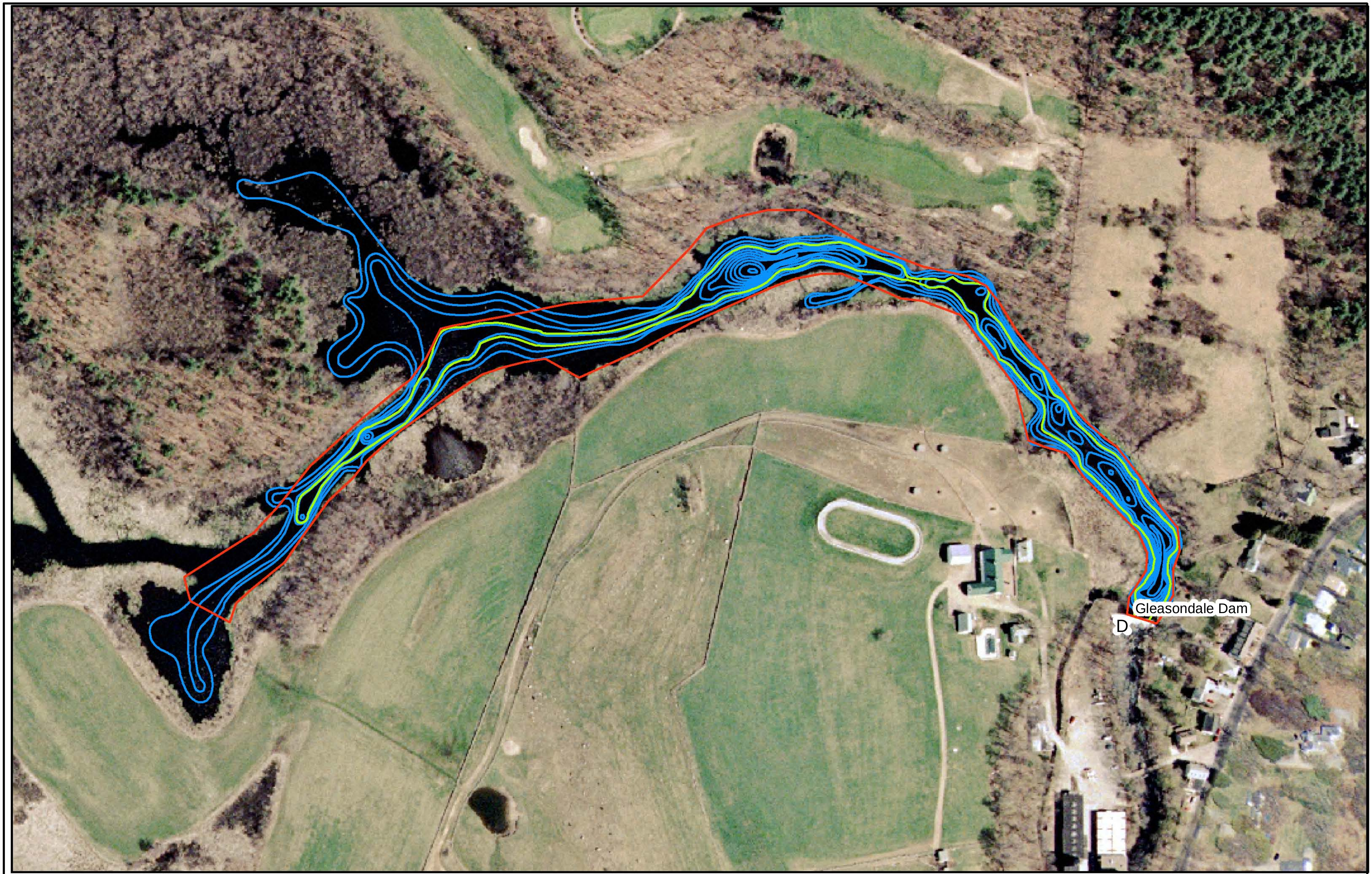

Figure 2-4: Dredging Extents for Gleasondale Impoundment

Assabet River

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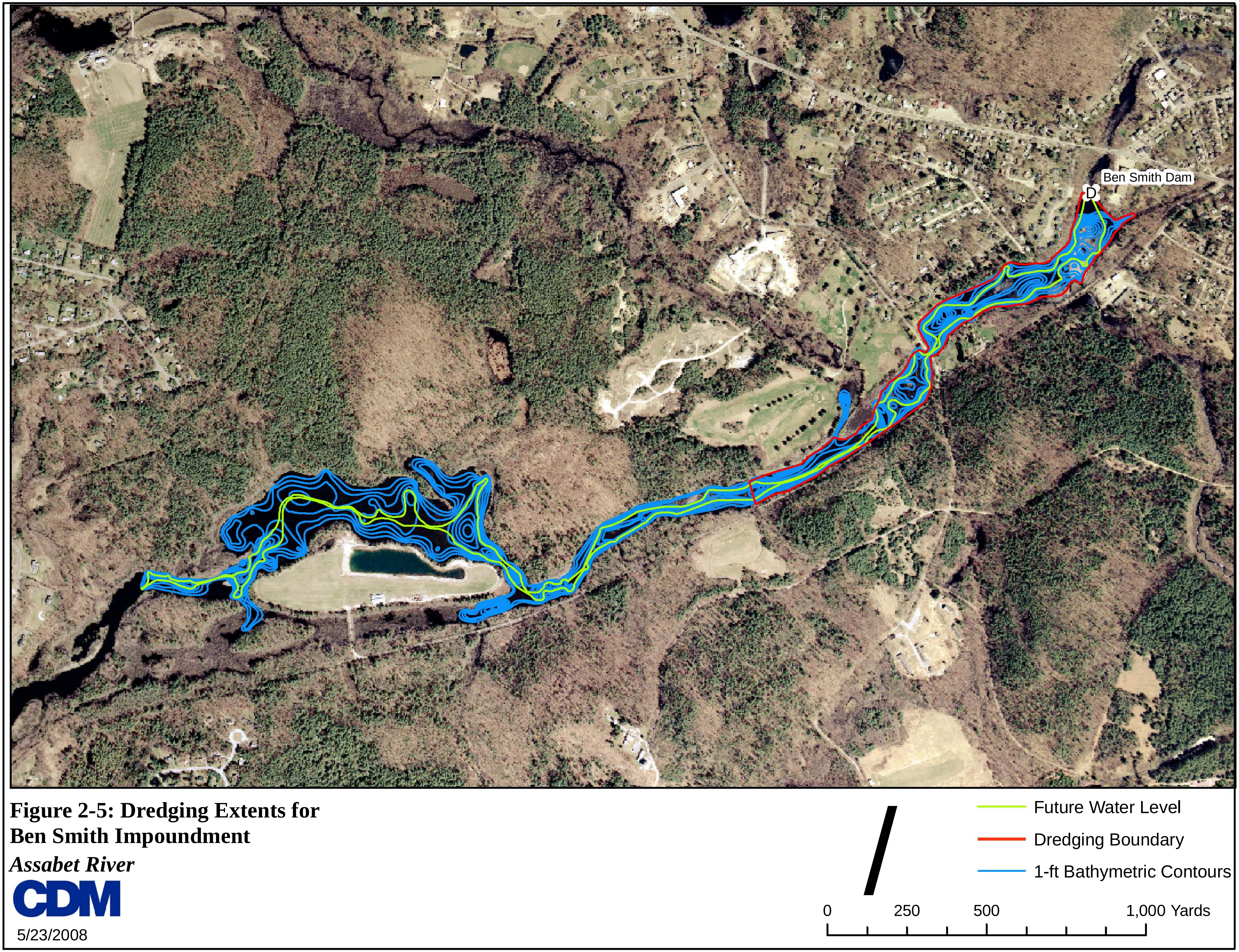

Figure 2-5: Dredging Extents for Ben Smith Impoundment

Assabet River

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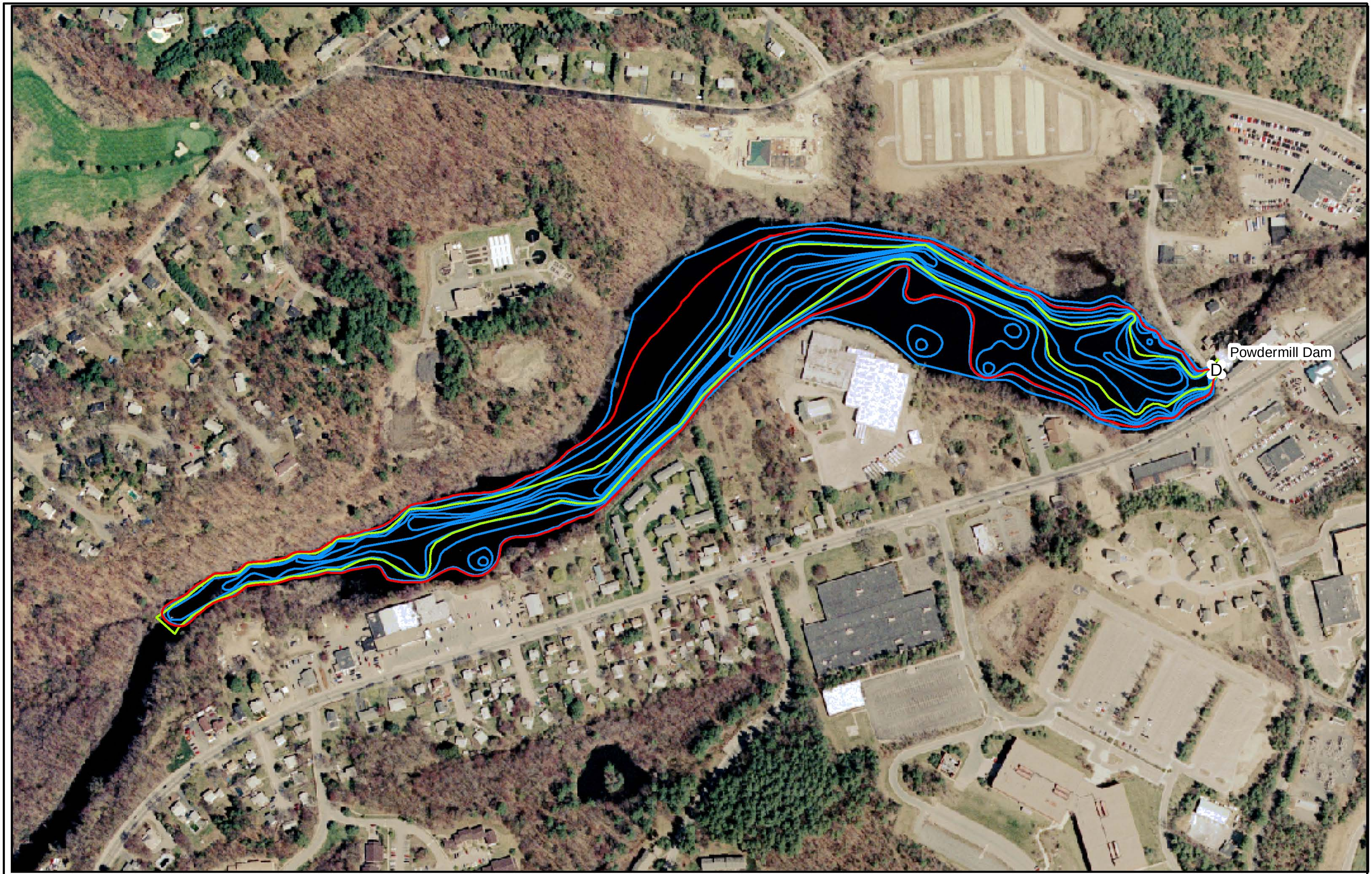

Figure 2-6: Dredging Extents for Powdermill Impoundment

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Section 3
Sampling and Analysis Considerations

3.1 Approach and Objectives

Considerations for additional sampling and analysis are outlined herein, with the objective of filling data gaps identified during the preliminary evaluation of existing data and to characterize sediment in the impoundments of each of the 6 dams being evaluated as part of this study. The proposed objectives for additional sampling and analysis include the following:

1. Obtain further data on the sediment in each of the impoundments sufficient to assist in preparation of a conceptual dredging and sediment management plan. Further data includes sediment sample collection and characterization, in situ sediment strength testing, SPT data and sample collection to evaluate conditions and soil stratigraphy below the sediment, Assabet River water level data to determine high, low, and mean water levels, additional mudline and sediment thickness probing, preparation of additional river cross-sections to estimate sediment thickness and assist in evaluation of river side-slope conditions, and an assessment of the physical characteristics of the perimeter of the impoundment areas, including any site or equipment access restraints and potential construction staging areas.

2. Perform laboratory studies and evaluations to determine the physical and analytical properties of the sediment, to evaluate the effectiveness of various dredging techniques, to evaluate the effectiveness of dewatering and/or bulking and/or solidifying the dredged sediment, and to evaluate various disposal options.

Based on a review of the existing data, a supplemental field characterization program was developed for consideration by MassDEP and project stakeholders, if the dam removal project continues to the next phases. The purpose of the supplemental field characterization program is to obtain information to further define subsurface conditions at the locations where dredging is proposed to take place. The supplemental field program will include the advancement of cores and test pits, with sediment sample collection. The analytical results will be used to determine the suitability of dredged materials for various disposal and/or reuse options.

The following subsections describe the rationale and approach, as well as specific procedures to consider as part of a supplemental sampling and analysis plan for potential future phases of the study.

For each impoundment, proposed sampling locations are based on the following:

- Results of previous investigations; and
- Areas preliminarily identified for sediment removal.

Samples are also proposed for collection along the proposed channel center line to obtain representative samples and to define stratification within the material to be dredged. The number of samples proposed was based on the testing frequency required under 314 CMR 9.07(2) and by the landfill disposal facilities. For reuse as cover at in-state landfills, there must be 1 core sample per 1,000 cubic yards of dredged sediment.

3.2 Sampling Procedures and Methodology

The following describes the general procedures that should be adhered to in order to ensure the representativeness and integrity of the sediment samples. Samples which best represent specific strata and are representative of the material to be dredged will be collected from each core.

Core logs will be prepared containing the identification of specific strata, grain size, staining and other visual observations. The following information will be recorded:

- Sampling personnel;
- Weather conditions;
- Date and time of field activities;
- Sample method;
- Position and depth of sample;
- Depth of overlying water;
- Field screening measurements;
- Instrumentation used and any deviations from the proposed methodology;
- Visual/olfactory observations; and
- Physical description of the material and geologic classification.

The sediment cores will be advanced using several methods depending on access limitations and subsurface conditions. It is proposed, however, that it be performed by vibracores using a lexan tube or similar collection tube. Vibracores provide intact sediment samples and allow for strata breaks to be visibly identified. Vibracores will be taken continuously until refusal is encountered, likely just below the bottom of the sediment. Sampling the bottom 6 inches to 1 foot below the sediment is important to understand river bottom conditions so that the appropriate dredging equipment may be used. Sampling below the bottom of the sediment may be achieved by placing a hammer device over the lexan tube (similar to an SPT hammer used during drilling) and "hammering" the tube into the soils.

In addition to the chemical testing requirements, sediment and surface water samples will be collected to further characterize the physical properties of the sediment and to evaluate the effectiveness of using geotubes and/or other applicable dewatering technologies to dewater, stabilize, or contain the sediment. Characterization and treatability studies will include the following types of testing:

- Performing in situ shear strength testing on sediment at various sample locations and depths;
- Physical characterization of the sediment;
- Belt Filter Press testing;
- Performing hanging bag tests to collect information applicable to geotube technology;
- Polymer analyses; and
- Solidification/Materials Bulking Studies to collect soil strength information applicable to transporting dewatered sediment off site to local landfills.

At the sediment sample locations, additional composite samples of sediment will be collected by a manual clamshell device and composited directly into 5-gallon buckets to assist in the dewatering and solidification/bulking studies. Approximately five to eight gallons of composited sediment samples should be collected per location.

Water samples of the Assabet River will also be collected at three locations in each impoundment to be used in the dewatering study. The water samples may be collected in 5 gallon buckets. Approximately two buckets should be collected at each location. The three water samples should be collected at the inlet, outlet, and center of each impoundment and then composited. The objective is to use the site waters and site sediments when performing the chemical conditioning program, so that the reactions with the polymers or alums during bench scale testing will be representative. If needed, the composited water sample can be analyzed for chemicals of concern (COCs) that would need to be addressed for water treatment. Effluent samples coming out of the hanging bag tests during the sediment dewatering study should also be tested for water treatment COCs.

Samples should be analyzed by EPA/MassDEP approved analytical procedures. Detection limits for samples will be consistent with regulatory limits. Quality Assurance/Quality Control (QA/QC) samples should be collected and analyzed and should include duplicate samples, trip blanks and matrix spike samples. These samples should be used to test for consistency and reproducibility for the overall sampling and analytical process. One out of every 20 samples should be collected for duplicate analysis. The analytical laboratories should be required to perform matrix spike analyses. The frequency of collecting samples for trip blank analysis should be established once the sampling program has been initiated and will be dependent on the number of samples that can be collected each day. The QA/QC samples are used to validate the analytical results for samples received from the laboratory.

3.3 Sample Parameters and Testing

Samples will be analyzed for the constituents listed in Table 3-1 as required in 314 CMR 9.07(2)(b)6. Additionally, physical lab testing should be performed on select core samples to accurately characterize the physical characteristics of the sediment and to assist in evaluating dredging, dewatering, and solidification/materials bulking options.

In addition to the sample parameters listed in Table 3-1, additional testing is outlined in the following subsections.

Table 3-1: Sampling Parameters and Physical Testing

Parameter	Test Method
Extractable Petroleum Hydrocarbons	EPH Method with GC/MS of PAHs
Volatile Organic Compounds	SW-846 5035
Metals	EPA Methods 6010, 7471
PCBs	NOAA Summation of Congeners
Pesticides	EPA Method 8081A
Conductance	EPA Method 120.1, 9050
TCLP Metals	As applicable
Reactivity Sulfide & Cyanide	EPA Method 7.3
Corrosivity	EPA Method 9040B/9045C
Percent Water	Computed
Paint Filter Test	EPA Method 9095A
Combined Sieve and Hydrometer	ASTM D422-63
Moisture Content	ASTM D2216
Organic Content	ASTM D2974
Specific Gravity	D 854
Atterberg Limits	ASTM D-4318
Grain Size and Hydrometer	ASTM D-422
Water (Moisture) Content	ASTM D-2216
Visual Classification	ASTM D-2488
Organics Content	ASTM D-2974
Bulk Density	ASTM C-127
Triaxial Compression Strength	ASTM D-2850

3.3.1 Dewatering Study

The dewatering study will include a chemical conditioning phase and evaluation of gravity and mechanical dewatering options. The purpose of the dewatering study is to determine what methods may be required to dewater the sediment such that they can pass paint filter testing in accordance with EPA Method 9095A and therefore be transported off site.

Composite samples of the sediment and site water would be shipped to a polymer vendor and belt filter press vendor for information gathering to analyze the effectiveness of those methods. For the chemical conditioning program, the polymer type and dosages will be recommended by the vendor and sediment dewatering rates will be evaluated. For the belt filter press, the dewatering rates, final solids content of the sediment, and belt press sizes will be evaluated.

A hanging bag test (HBT) will be performed to evaluate the use of geobag technology. The test will be performed with the polymer and dosage recommended by the polymer vendor and would be scheduled to run for approximately three weeks to simulate a practical time limit for dewatering in the field. When the additives are thoroughly mixed in, the sediment will be poured into the hanging geotextile and the test will begin. The hanging bag is a geotextile material used to construct geotubes and sewn together to form a container that will support and contain a measured amount of the sediment. The geotextile tube, or "bag", has a circumference of approximately 45 inches and is approximately 65 inches long and attached to a metal frame to hold it in a vertical position. The geotextile allows the water to escape while containing the solids material, simulating the geotube dewatering process. Effluent from the sediment pours out the geotextile and is collected at the bottom of the bag with a collection pan.

Measurements would generally include the following:

- Solids content of the sediment over time;
- Dosage of polymer added to sediment;
- Total suspended solids (TSS) content of the effluent;
- Concentrations of site-specific analytes of the effluent; and
- Visual observations of the solid cake formed at the bottom of the geotextile.

Analytical testing will be performed on the effluent to identify any potential water treatment needs.

At the conclusion of the HBT, the sediment inside the geotextile will be collected and used for the bulking and/or solidification testing.

3.3.2 Bulking and/or Solidification Testing

Bulking/solidification testing should be performed with the dewatered sediment to collect information to further evaluate sediment disposal options. The testing will help determine if the dewatered material can be transported to a landfill for disposal and, if not, what dosages of bulking and/or solidification reagents are needed to achieve suitable solids content for sediment transport. The reagents tested will include Portland cement and locally identified additives such as a fly ash or slag cement.

Additives will be blended at different dosages with the dewatered sediment and tested for unconfined compressive strength. Approximately six mixes will be tested at 7-day, 14-day, and 28-day strength intervals. At the conclusion of the testing, approximately two samples will be analyzed for TCLP to determine if the constituent in the sediment would leach out above regulatory levels.

3.3.3 Sample Disposal

All sample materials at the completion of the investigation will be composited into 5 gallon buckets at the laboratory and transported back to the site.

3.4 Sample Locations

For the sampling parameters and tests discussed in the previous section, Table 3-2 below summarizes the number of sample locations for each impoundment. Sample locations for each impoundment were selected based on spacing, sediment thickness, and water depth. Fewer proposed samples were identified in areas with existing data unless the results showed elevated concentrations. At these locations, additional samples were proposed to further define the area.

For the sediment samples requiring analytical testing, at each location, between 2 and 4 sediment cores will be collected at varying depths depending on the sediment thickness. For each test pit, between 3 and 5 samples at varying depths will be extracted for analysis. Samples from cores within the same reach that show similar physical characteristics may be composited into one sample. Samples collected in areas where elevated concentrations were found or at targeted locations will not be composited. Combined with the USGS sediment study, this sampling plan is expected to yield a sufficient number of measurements to comply with the sampling and analysis frequency requirements specified under 314 CMR 9.07(2) and for reuse at in-state landfills.

Table 3-2: Proposed Sampling for Assabet River Impoundments

Impoundment	Sediment Core Locations* – Analytical Testing	Sediment Core Locations* – Geotechnical Testing	Test Pits	Water Sampling Locations
Aluminum City	2	6	1	3
Allen Street	1	12	1	3
Hudson	14	18	4	3
Gleasondale	4	13	1	3
Ben Smith	12	18	4	3
Powdermill	12	20	3	3

* Geotechnical sampling locations are inclusive of analytical sampling locations. For example, the Aluminum City impoundment sampling will consist of six sample locations where geotechnical testing will be performed, and one of the six sample locations will also include analytical testing.

Actual sediment core/test pit locations will be determined in the field based on factors such as access and subsurface conditions. Each location will be tied into the survey grid.

Sampling is also proposed for additional areas in each impoundment however at a lower testing frequency. The exception will be in areas where higher concentrations of constituents have been found and at locations identified through a complete due diligence process where current or historic uses may have impacted sediment.

Figures 3-1 through 3-6 include a proposed subsurface exploration plan detailing the sampling locations.

3.5 Data Management

The analytical results from the sediment characterization program will be entered electronically into the geographical information system (GIS) database. Spreadsheets of these data should be prepared in which the data are summarized and compared, as appropriate, with sediment and/or landfill disposal criteria. This information will also be presented graphically to illustrate the results and identify trends where present.

3.6 Sampling and Analysis Cost

The cost to conduct this sampling and analysis plan for the proposed area to be dredged is shown in Table 3-3 for each impoundment. The cost includes sample collection, laboratory analysis, data management, and a summary letter report that provides an evaluation of the data collected from the field investigation, combined with the results of previous environmental studies, to determine the suitability of dredged materials for various disposal options.

The costs were developed as planning level estimates only and presume that the proposed work including sample collection, testing, analyses, data evaluation, and report preparation will be conducted for each impoundment separately. Sample frequency and testing described herein may be refined based on discussions with the regulatory agencies, conditions observed in the field and the results of testing conducted at the other impoundments.

Table 3-3: Proposed Sampling and Analysis Costs*

Aluminum City	$94,700
Allen Street	$101,400
Hudson	$165,600
Gleasondale	$118,200
Ben Smith	$161,000
Powdermill	$151,600

** Sampling and analysis costs for samples in dredging area only.*

Figure 3-1: Proposed Subsurface Exploration Plan
Aluminum City Impoundment
Assabet River

CDM

5/23/2008

0 25 50 100 Yards

Proposed Vibracore
Proposed Test Pits
USGS Borings
Future Water Level
Dredging Boundary
1-ft Bathymetric Contours
HEC Cross-Section

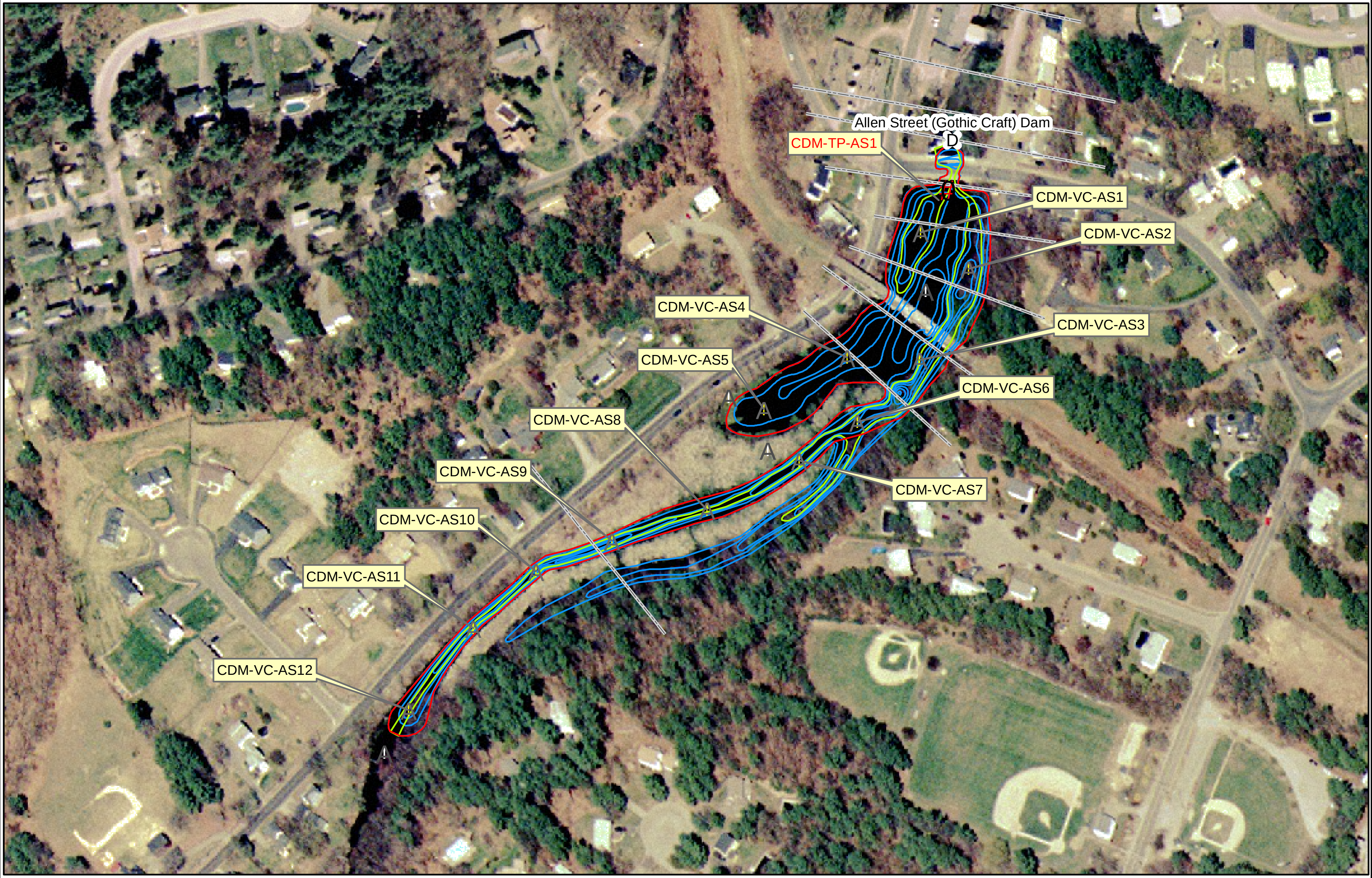

Figure 3-2: Proposed Subsurface Exploration Plan
Allen Street Impoundment
Assabet River

CDM

5/23/2008

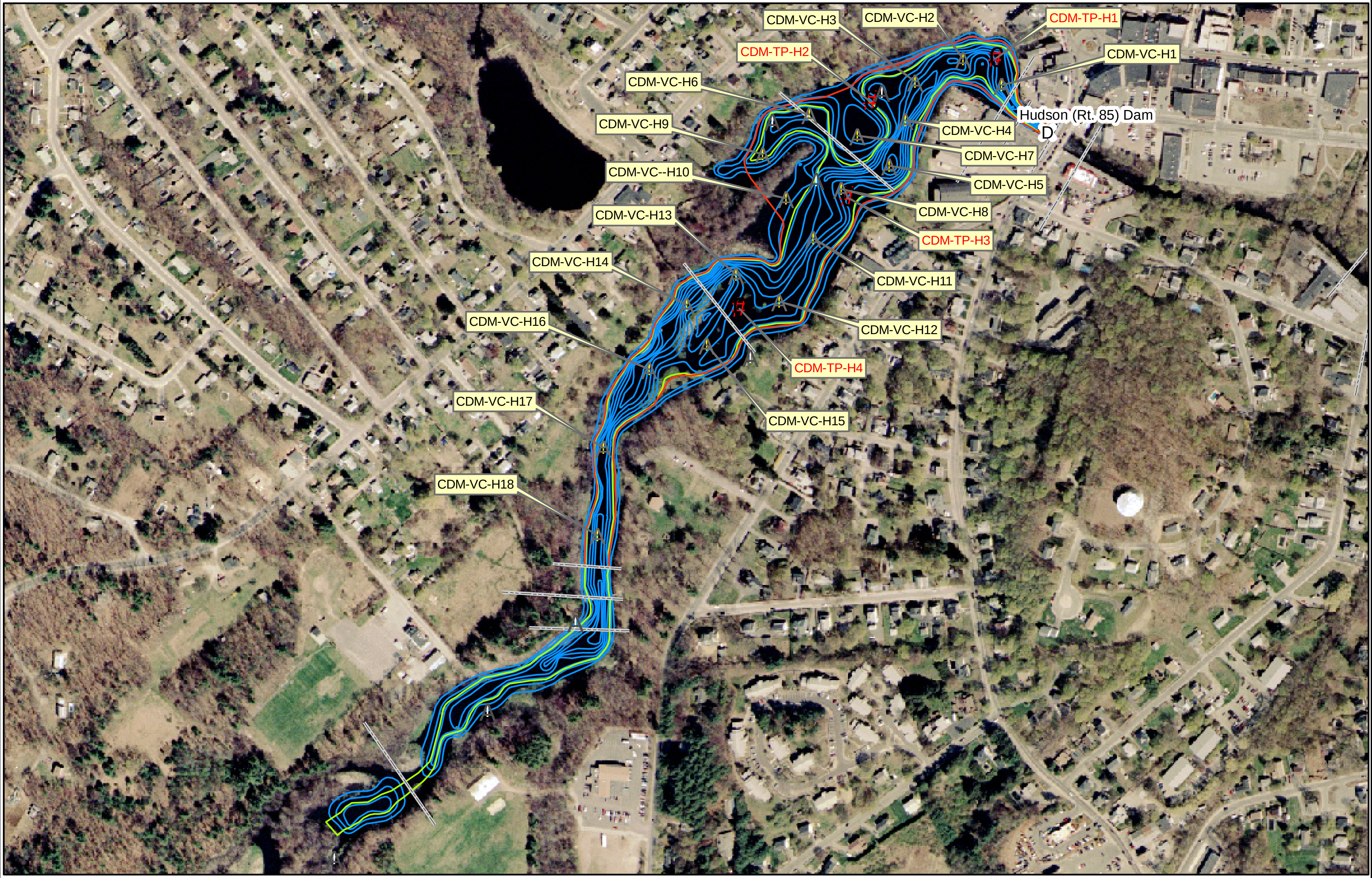

Figure 3-3: Proposed Subsurface Exploration Plan
Hudson Impoundment
Assabet River

CDM

5/23/2008

Proposed Vibracore
Proposed Test Pits
USGS Borings
Future Water Level
Dredging Boundary
1-ft Bathymetric Contours
HEC Cross-Section

0 100 200 400 Yards

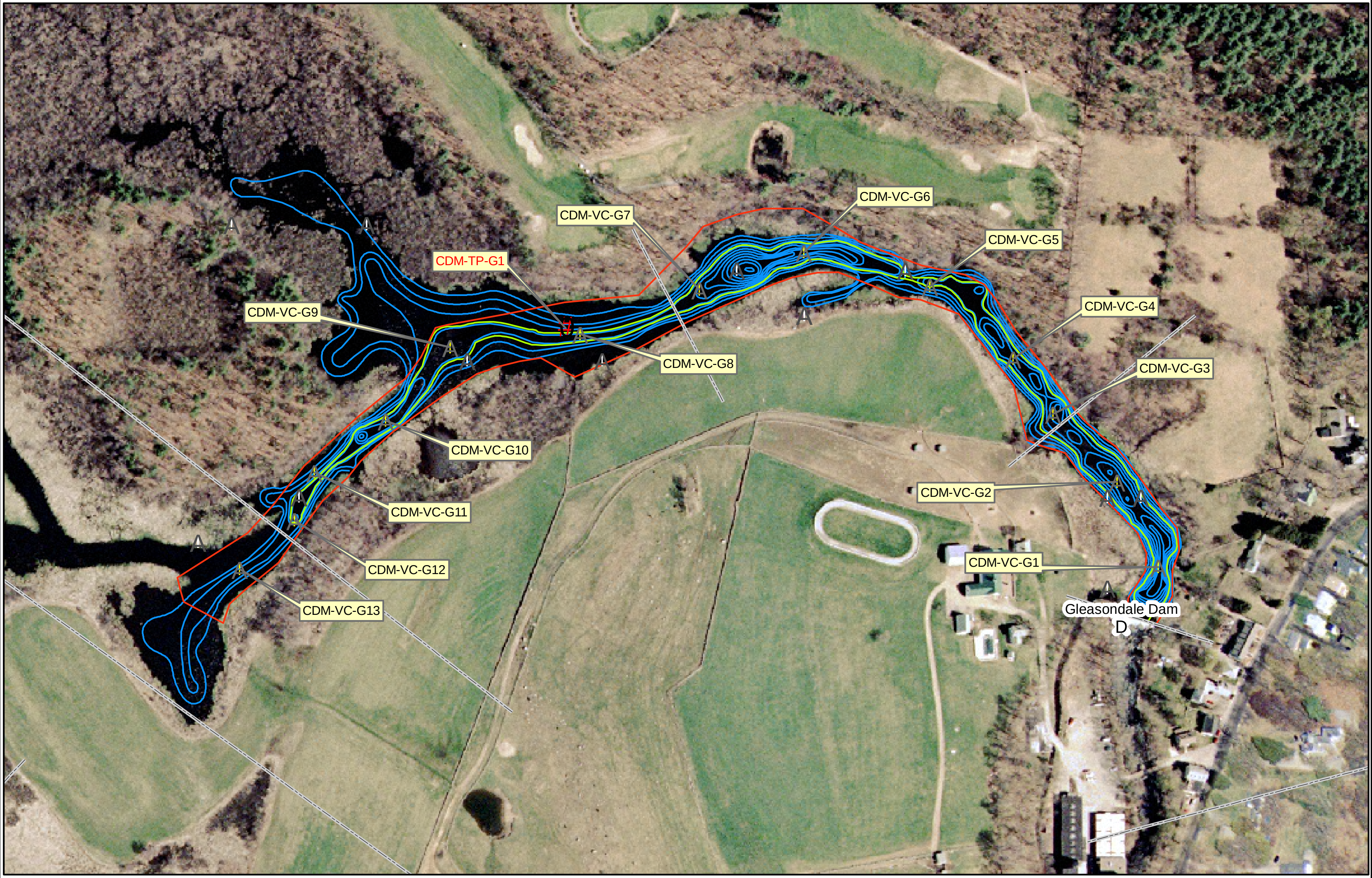

Figure 3-4: Proposed Subsurface Exploration Plan
Gleasondale Impoundment
Assabet River

CDM

5/23/2008

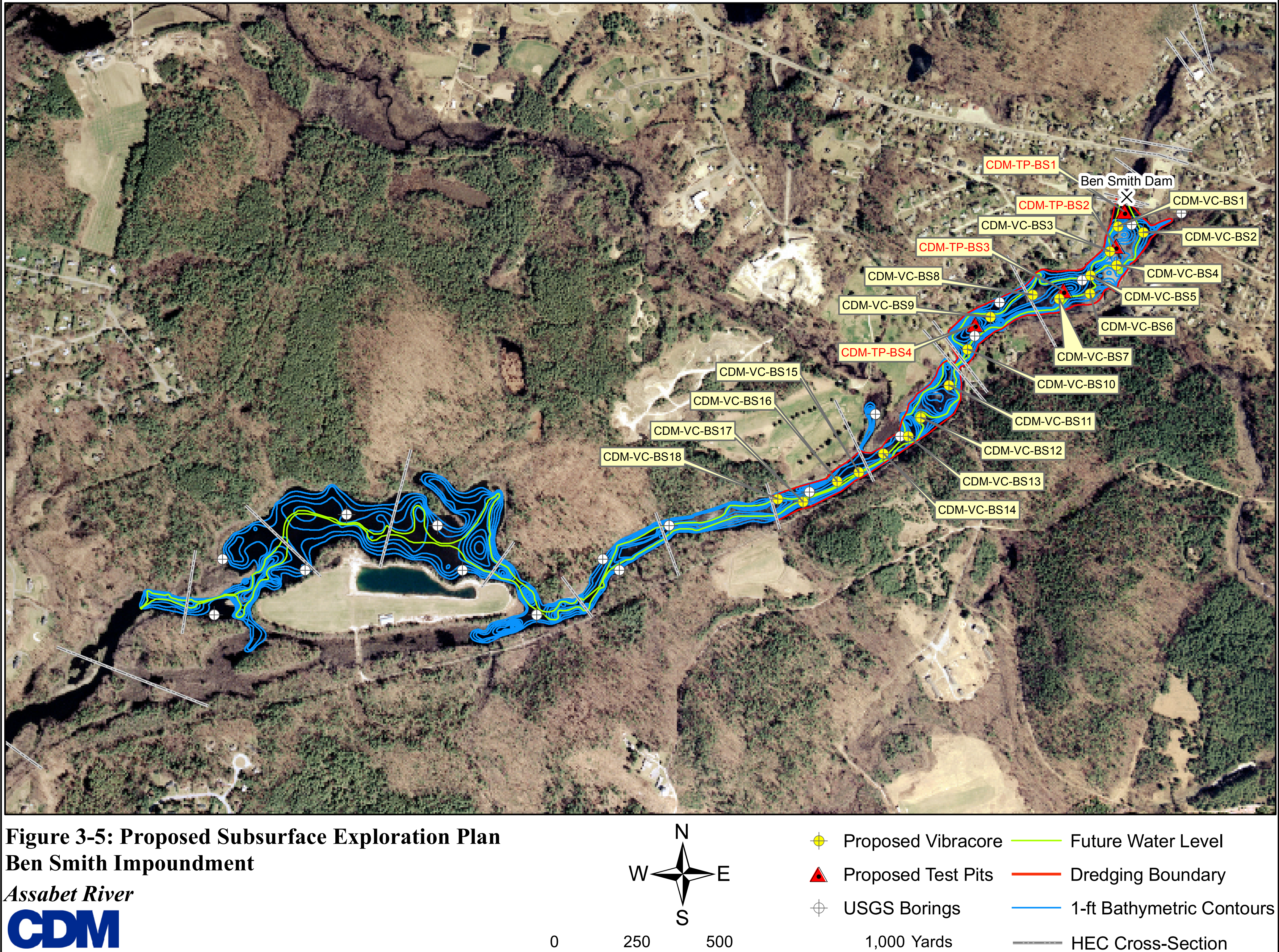

Figure 3-5: Proposed Subsurface Exploration Plan
Ben Smith Impoundment
Assabet River

CDM

5/23/2008

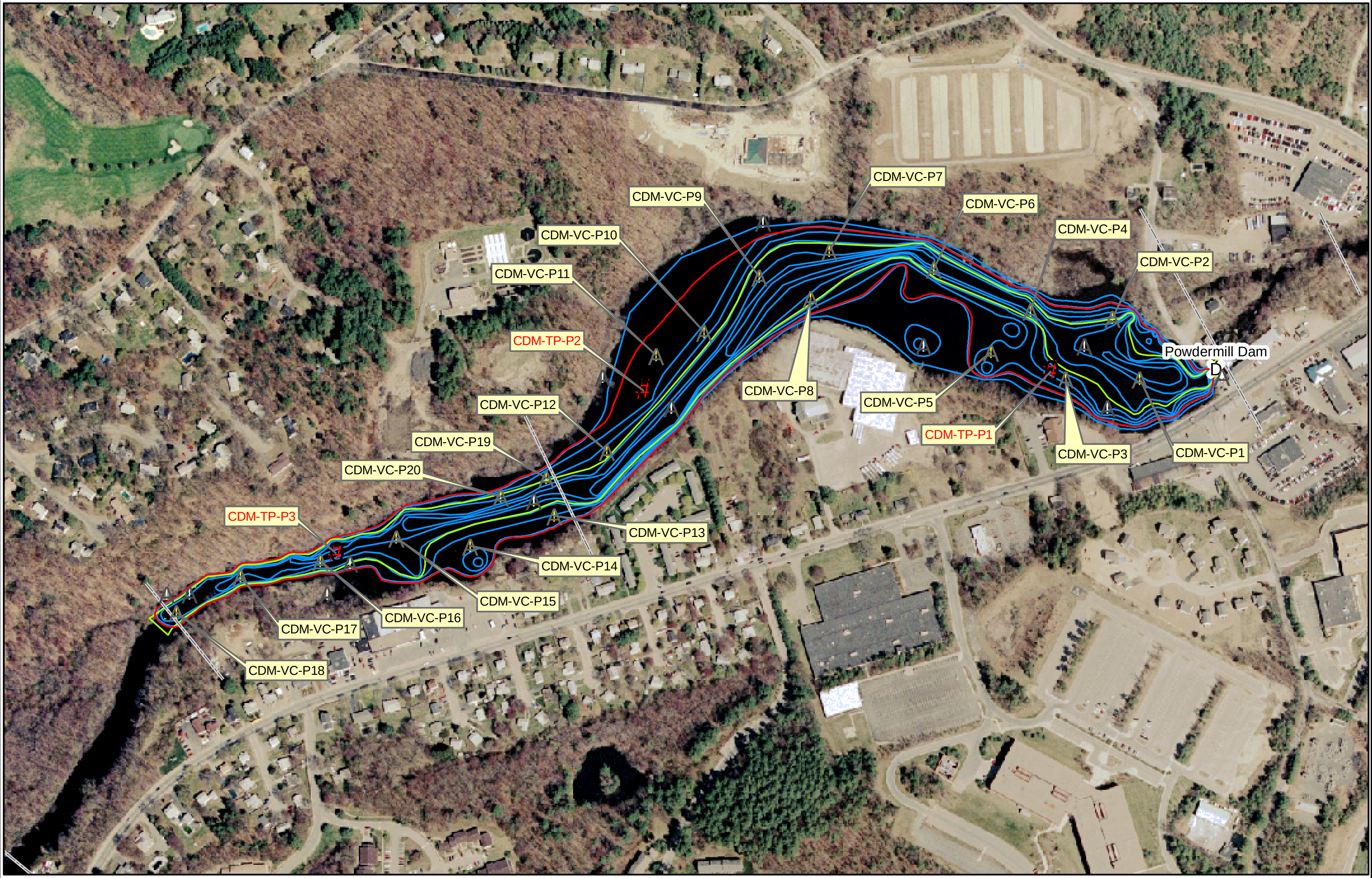

Figure 3-6: Proposed Subsurface Exploration Plan
Powdermill Impoundment

Assabet River

CDM

5/23/2008

Section 4
Sediment Management Considerations

Management of the dredged sediment must consider factors such as dredge type, physical and analytical properties of the sediment post dredge, a spoils containment and processing area, materials handling, including dewatering and/or bulking of the sediment, water handling and water treatment, if necessary, and final sediment disposal.

4.1 Sediment Removal/Dredging Considerations

When evaluating dredging and excavation options below the water table, it is important to consider many factors such as the body of water, the physical and analytical properties of the sediment, quantity of materials to be dredged, management and materials handling of the dredged sediment, potential water treatment/management of the water associated with the dredged sediment, the physical constraints of the site, including proximity to shorelines and oversized materials collecting adjacent to existing dams, the river bottom materials, required removal levels of dredged sediment, consideration of dredging contaminated sediment and/or any “hot spots”, water quality during dredging operations, required construction schedule constraints (production rates), and anticipated dredging costs.

Typical options for sediment removal include hydraulic dredging and mechanical dredging. Hydraulic dredging involves a floating barge with an attached cutterhead that is lowered into the sediment. The cutterhead will rotate and excavate the sediment, which gets pumped through a dredge pipe from the cutterhead to a location on shore. Hydraulic dredging requires a mixture of water from above the mudline with the sediments to create a slurry material that is capable of being pumped.

Mechanical dredging is typically done with a crane mounted to a barge and generally uses either a clam bucket or dragline bucket. The dredged sediment would be stored on the barge and then unloaded on land with a crane and bucket. Generally, mechanical dredging is advantageous when water is shallow and/or the sediment has a high solids content and/or has a large percentage of coarse grained materials. The advantage to mechanical dredging is that the dredged material is usually at a higher solids content than the “slurry” that comes out of the hydraulic dredge pipe, therefore materials management is easier and less space is required. Additionally, less water treatment is required at sites where treatment is required. Hydraulic dredging is generally preferred over mechanical dredging when there is a large depth to mudline, when the sediment has low solids content and are already in fluid form (most sludge, for example), and when there are minimal access restrictions so that the dredging can be performed in a continuous manner. Additionally, hydraulic dredging is usually performed at a faster rate than mechanical dredging, but there are many different sizes and production capacities.

The removal levels of dredged sediment and river bottom materials are important factors when considering dredging operations. For example, if 100% sediment removal is required and dredging extends to the river bottom, any boulders or oversized materials at the bottom of the river may potentially disrupt the cutter/slurry pipe operations and halt dredging productions for periods of time. If a small volume of sediment may be left in place (e.g., < 1 foot), hydraulic dredging operations may not be affected by adverse river bottom conditions.

If contaminated "hot spots" are identified that may require different sediment disposal options, then discrete dredging at those hot spots may be desirable, in which case mechanical dredging may be considered. Hydraulic dredging typically results in more sediment in suspension as the sediment mixes with water and gets pumped into the slurry pipe. This water quality issue may be alleviated with installation of silt curtains around the dredge pipe; however the silt curtains may slow the dredging operations. The water quality is an important concern because any exceedances can potentially halt the dredging operations.

Another factor in determining dredging operations is the proximity of the dredging equipment to the river bank necessary to remove the sediment. A hydraulic dredge operation usually requires a minimum of 3 to 4 feet of water to operate, and sediment removal along or adjacent to the river banks may require conventional excavator equipment. One possibility to improve access to the sediment during dam removal is to remove the dam in controlled increments, slowly lowering the water table and reducing the width of the river channels in the impoundments behind the dam. Once the channels are reduced, the exposed sediment along the river banks may be easier to access with conventional excavator equipment where a hydraulic dredge may not reach.

4.2 Dewatering Considerations

Dewatering methods include gravity dewatering, mechanical dewatering, and dewatering with the aid of chemical conditioning. Gravity dewatering may include a settling basin where hydraulically dredged sediment may be piped into the basin. Should the sediment be hydraulically dredged, the material coming out of the dredge pipe will be in "slurry" form and require more dewatering and water management and more space than mechanical dredging because the increase in water in the dredge mix causes an increase in volume of dredged material. Should the sediment be mechanically dredged, the sediment will typically have a higher solids content and may perhaps be dewatered via gravity by placing the sediment in relatively long piles as windrows and allowing the water to drain off of the piles.

Mechanical dewatering may include the use of filter presses. Chemical conditioning includes blending polymers or alums into a dredged material to allow for the water to disassociate with the solids easier and to transform soluble contaminants to the solid phase.

Geobag (or geotextile tube) technology is an alternative to a settling basin or windrowing and employs a combination of gravity draining, mechanical dewatering, and chemical conditioning to dewater the sediments. Sediment is piped into the geobags, which consist of geotextiles that are designed to allow water to pass through but to trap solids. As the geobags fill up, water drains out of the sediment and can be collected outside the geobags, usually with a lined system and gravity drainage paths. Polymers and other chemicals may be added to the sediment to increase the dewatering efficiency. Over time, the sediment continues to lose water. When the dewatering is complete, the geobags may either be transported or opened up and the dewatered sediment can be managed. The sediment may then be bulked and/or solidified, if necessary, to meet landfill strength requirements.

4.3 Disposal Considerations

As previously discussed in Subsection 2.2.4, existing sediment data for the impoundments in the Assabet River indicate that the sediment may meet the thresholds of the RCS-1 Category with a disposal option of upland placement, or may meet the thresholds for reuse at an in-state lined landfill. However, should the reuse limits be exceeded, the sediment may have to be disposed of at an out-of-state landfill. Landfill disposal options will generally require the sediment to have specific solids content and strength properties. Sediment is required to have a solids content sufficient to pass a paint filter test (EPA Method 9095A) prior to off-site transport, which usually requires a dewatering operation. Additionally, the sediment must have minimum strength properties to satisfy the specific landfill acceptance criteria, which usually requires a bulking and/or solidifying step.

4.4 Exposed Sediment Considerations

The removal of any of the six study dams may result in the exposure of sediment previously under water. Once exposed, the sediment if exhibiting characteristics of soil could then be regulated under the MCP and the notification thresholds for contaminant levels in soil. Because the physical and chemical characteristics would likely be altered as the sediment becomes exposed, sampling of this material under this phase of the investigative process is not proposed. Rather, the results of the sediment management program described herein will be evaluated and further testing needs will be determined.

Section 5
Recommended Plan

5.1 Summary of Sampling and Analysis Plan

A sampling and analysis plan has been proposed in Section 3 to fill in data gaps identified during the preliminary evaluation of existing data and to characterize the sediment in the impoundments of each of the six dams being evaluated as part of this study. Locations for extracting sediment core samples have been chosen in order to further investigate elevated contaminate concentrations reported by the USGS in 2003, meet a target of one sample per 1,000 cubic yards of sediment to be dredged, and to provide adequate coverage to properly characterize the subsurface of each impoundment. The sampling methodology, chemical parameters, and physical testing described in Section 3 will provide necessary information to evaluate the sediment management options. The estimated cost for the sampling and analysis for the six Assabet River impoundments is shown in Table 3-3, and will be completed prior to dredging as the results of the analyses will affect the final sediment management plan.

5.2 Management Plan

5.2.1 Dredging

Based on the impoundment dimensions shown on Figures 2-1 to 2-6 and on limited available physical data, a preliminary recommendation is to perform mechanical dredging of the Aluminum City impoundment sediment and hydraulic dredging of the other five study impoundments. Table 5-1 lists the dimensions, water depths, and sediment thicknesses of each impoundment at the areas where dredging is required.

Table 5-1: Impoundment Dimensions, Water Depths, Sediment Thicknesses

Impoundment	Length of Dredged Area (ft)	Width of Dredged Area (ft)	Average Water Depth (ft)	Maximum Water Depth (ft)	Average Sediment Thickness (ft)	Maximum Sediment Thickness (ft)
Aluminum City	400	30-65	2.5	3.5	1	4
Allen Street	1,600	100-300	2.5	6	2.5	>7
Hudson	3,700	130-360	3	6	3	7
Gleasondale	4,000	80-200	4	11	4	>7
Ben Smith	4,200	100-500	4	10	2	5
Powdermill	4,200	100-450	3	7	4	>7

As shown in Table 5-1, maximum water depth of Aluminum City impoundment is 3.5 feet, the channel width is only 30 to 65 feet in the area to be dredged, and the length of the channel is only 400 feet. These shallow water conditions and narrow channels are not conducive to hydraulic dredging and therefore mechanical dredging is recommended for the Aluminum City impoundment. In the larger impoundments, maximum water depths range from 6 to 11 feet and channel widths range from 80 to 500 feet. For these impoundments, relatively small hydraulic dredge equipment may be feasible to decrease the construction duration, and sediment that is in shallow waters on the river banks may be removed using conventional excavator equipment.

Dredging equipment is available in various sizes and production varies, but for the study impoundments, hydraulic dredging production is estimated at approximately 500 gallons per minute (gpm) with a maximum dredging production of up to 1,000 gpm. Mechanical dredging production rates are estimated at approximately 10 – 20% the hydraulic dredge rates.

Table 5-2 lists the approximate volume of sediment to be dredged and estimated dredging duration, based on the following assumptions:

- In situ sediment percent solids range of 40 – 60%;
- Dredged sediment percent solids of 10% out of the slurry pipe;
- Dredging production rates of 500 – 1,000 gpm;
- 70% dredging efficiency;
- Approximately 8 – 16 hour work days; and
- 22-day months

These assumptions are based on limited available data and are for planning purposes only, the estimated rates and properties would be refined after performing the sampling and laboratory studies and after discussions with dredging contractors.

Table 5-2: Estimated Dredging Rates

Impoundment	Aluminum City	Allen Street	Hudson	Gleasondale	Ben Smith	Powdermill
Volume of sediment to be dredged (yd^3)	1,304	2,237	71,558	27,856	67,601	65,833
Months dredging, 500 gpm, 8hr/day	Mechanical Dredging, 3-6 months	0.6-1.0	20-30	8-12	19-29	19-28
Months dredging, 500 gpm, 10hr/day		0.5-0.8	16-24	6-9	15-23	15-22
Months dredging, 500 gpm, 16hr/day		0.3-0.5	10-15	4-6	10-14	9-14
Months dredging, 1,000 gpm, 8hr/day		0.3-0.5	10-15	4-6	10-14	9-14
Months dredging, 1,000 gpm, 10hr/day		0.3-0.4	8-12	3-5	8-12	7-11
Months dredging, 1,000 gpm, 16hr/day		0.2	5-8	2-3	5-7	5-7

As shown in Table 5-2, increasing production rates and dredging equipment sizes will make a noticeable difference with dredging schedules for the three impoundments where over 65,000 cubic yards of sediment is anticipated to be removed (Hudson, Ben Smith, Powdermill). However, as discussed previously, dredging equipment is constrained by several factors, including the impoundment water depth, channel widths, and river bottoms, so these estimations will need to be refined as more information becomes available. Any oversized particles such as tree brush, roots, debris adjacent to the dams, cobbles, will need to get addressed as part of the dredging operations.

5.2.2 Dewatering

The preliminary recommended approach for the dewatering operations at the six study impoundments is to provide a laydown area station that is sufficiently equipped to handle oversized particle screening, desanding, geotextile bags, chemical conditioning, and water treatment operations.

The oversized particles may be screened with a mechanical screener, usually 4 to 6 inch maximum diameter particle size, and the oversized material should be quickly segregated and stockpiled to prevent any disruptions to the dredging operations.

The desanding operations would involve a series of hydroclones and be performed prior to placement of the dredged material into the geotextile bags. The hydroclones would separate the sand out of the slurry suspension during hydraulic dredging and the separated sand would be stockpiled onto a containment area where it would quickly dewater via gravity drainage and the water would be able to be appropriately managed and treated. This is done because the geotextile bags and chemical conditioning dewatering is primarily performed to dewater fine-grained materials and there is a cost-savings associated with not treating the coarse-grained materials with the chemicals and saving headspace in the geotextile bags.

Based on the limited sediment grain size available, desanding operations may separate out on the order of 50% or more of the dredged sediment at the Aluminum City, Hudson, Gleasondale, and Powdermill impoundments. Desanding operations may separate out on the order of 20-40% of the dredged sediment at the Allen Street and Ben Smith impoundments.

The chemical conditioning and geotextile bag operations represent the majority of the dewatering operations. Typically the dredged sediment from the slurry pipe gets pumped directly into the geotextile bags, with polymers and alum mixed into the geotextile bags from an adjacent portal to react chemically with the sediment and allow the sediment to dewater faster. The geotextile bags are laid out side by side in rows and are filled, dewatered, refilled, and then replaced when dewatering has been completed and the sediment has been transported off site. The geotextile bags are lined and surrounded by berms to contain the water that comes out of the bags for proper management or treatment. Water that initially comes out of the bags tends to contain a higher total solids content than water that comes out of the bags at later dewatering stages, so this water may be recirculated back into the geotextile bags to lower the total solids content in the water and reduce water treatment levels.

Water management and water treatment are critical when planning the dewatering operations, especially during hydraulic dredging operations where generally a water volume of two to five times the volume of sediment is mixed in during dredging operations. Table 5-3 lists an estimate for the amount of water to be managed and treated during the dewatering operations.

Technical considerations for determining appropriate sites include assessing the topography, existing site features, proposed traffic patterns, subsurface ground conditions, and groundwater levels at each proposed dewatering site. The dewatering sites should be relatively flat and dry and have sufficient bearing capacity to support construction equipment, truck traffic, materials, the geotubes filled to capacity, and piles of sediment. If the dewatering site contains organic material or soft soils, the soils may need to be stripped or excavated and replaced with a suitable sub-grade material. A work pad may need to be constructed to provide adequate support. Subsurface investigations should be performed to assess the conditions at the dewatering sites. Additionally, traffic patterns should be established so that trucks can be loaded and unloaded efficiently.

Non-technical considerations may include permitting issues, construction noise levels and possible odor concerns with the sediments.

Table 5-3: Estimated Water Volume to be Managed/Treated

Impoundment	Volume of sediment to be dredged (yd^3)	Water Volume to be Managed/Treated (MG)
Aluminum City	1,304	1-2
Allen Street	2,237	2-3
Hudson	71,558	60-100
Gleasondale	27,856	20-40
Ben Smith	67,601	60-95
Powdermill	65,833	55-90

Water storage and water treatment equipment should be sized to handle the estimated quantities based on anticipated dredging rates. Based on estimated volume of sediment to be dredged and dredging operations, preliminary footprints of the dewatering operations were sized as shown in Table 5-4.

Table 5-4: Preliminary Dewatering Operations Footprints

Impoundment	Volume of sediment to be dredged (yd^3)	Dewatering Operations Footprints (Acre)
Aluminum City	1,304	1-2
Allen Street	2,237	1-2
Hudson	71,558	3-6
Gleasondale	27,856	2-4
Ben Smith	67,601	3-6
Powdermill	65,833	3-6

These preliminary footprints can be adjusted by changing dredging production rates, and additional construction sequence planning. The footprints assume that the dewatering and off-site transport for the sediment at the Hudson, Gleasondale, Ben Smith, and Powdermill impoundments will be performed multiple times during the dredging operations by using the same footprint during construction. In other words, geotextile bags that contain dewatered sediment will be emptied and replaced in the same footprint and refilled as necessary.

The following potential dewatering site locations were provided by the USACE in an interim task report titled Assabet River, Massachusetts, Sediment and Dam Removal Study. Each of the potential dewatering areas identified by the USACE was compared to estimated dewatering areas provided in Table 5-4: Preliminary Dewatering Operations Footprint.

Based on this review, the potential sites identified at Aluminum City, Gleasondale, and Ben Smith are adequate in size for dewatering areas. For the Allen Street impoundment, Sites 1 and 3 are adequate in size, but Site 2 is smaller than the estimated required area. Site investigation of the Hudson impoundment did not identify any potential sites for dewatering. Lastly, the potential dewatering area for the Powdermill impoundment was not shown in the USACE report, therefore the estimated area is unknown.

Table 5-5: Potential Dewatering Sites

Impoundment	Site #	Ownership	Location	Estimated Area	General Notes
Aluminum City	1	Private	Directly across from Rt. 20	3 acres	
	2	Town	½ mile east of the dam	4 – 5 acres	Peaslee School's Baseball fields
Allen Street	1	Town	½ mile northeast of dam	2 acres	Northborough conservation property
	2*	Commercial	¼ mile northeast of dam	0.5 – 0.75 acres	Loam and mulch facility, close to residential community
	3	Town	¼ mile southeast of dam	2.5 acres	Town baseball fields
Hudson	0	No potential dewatering sites identified, highly commercialized and residential owned			
Gleasondale	1	Private	West of dam	30 – 40 acres	Horse farm
	2	Commercial	East of dam	50 – 60 acres	Golf course
Ben Smith	1	Private	East of dam	10 – 12 acres	Mill Complex
	2	Commercial	¼ mile southwest of dam	10 – 15 acres	Golf course
	3	Town	1 mile south of dam	8 – 12 acres	School fields
Powdermill	1	Commercial	½ mile east of dam	Unknown	Sand and gravel facility

**Allen Street Site 2 is smaller than the estimated area required for dewatering.*

5.2.3 Disposal

Geotextile bags are advantageous for analytical characterization and disposal because they can be sampled as individual units. Sediment requiring off-site landfill disposal will need to meet the following physical property requirements prior to transport off site:

- Sediment must achieve compliance with 40 CFR 264.314 and 265.314 by passing the Paint Filter Liquids Test (EPA Method 9095A); and
- Sediment must meet landfill specific strength parameters.

The sediment should pass the Paint Filter Liquids Test after the chemical conditioning and geotextile bag dewatering operation. Laboratory testing and further pilot testing may be performed to determine appropriate polymer/alum dosages and allowable dewatering time. Once the sediment in geotextile bags have been dewatered, it is easy to take sediment samples at several locations in the geotextile bag for Paint Filter Liquids Testing. Typically, the geotextile bags may hold between 500 to 2,000 cubic yards of sediment.

Once the sediment has been deemed free of liquids, it must meet landfill specific strength parameters. Generally, a coarse-grained material may meet these parameters after dewatering, whereas fine-grained material or material with high organics content may need to be mixed with solidification additives or bulked with dry, coarse-grained material to satisfy the strength requirements. For planning purposes, it is assumed that a pozzalonic additive would be applied at the rate of 5-10% of the dewatered sediment by mass. Solidification or bulking may be performed by cutting open the geotextile bag and mixing the material with the solidification or bulking agent via backhoe bucket or similar mixing equipment. Should no additional solidification or bulking be required, the geotextile bags may be able to be loaded into trucks intact.

Table 5-6 presents the volume of sediment that is estimated to be disposed of assuming a 10% increase in volume by solidification or bulking.

Table 5-6: Estimated Sediment Volume for Disposal

Impoundment	Volume of sediment to be dredged (yd^3)	Volume of dewatered sediment (yd^3)	Volume of sediment to be disposed of (yd^3)
Aluminum City	1,304	950-1,300	1,000-1,450
Allen Street	2,237	1,600-2,200	1,800-2,500
Hudson	71,558	52,000-72,000	57,000-79,000
Gleasondale	27,856	22,000-28,000	25,000-31,000
Ben Smith	67,601	60,000-68,000	54,000-75,000
Powdermill	65,833	53,000-66,000	58,000-73,000

5.2.4 Exposed Sediment

As described in subsection 4.4, removal of the dams may result in the exposure of sediment previously under water. Exposed sediment that exhibits the characteristics of soil could then be regulated under the MCP and the notification thresholds for contaminant levels in soil. Data collected from this supplemental investigation including pre- and post-dredged sediment data should be evaluated to determine further testing needs.

5.3 Construction Sequencing

Factors affecting construction sequencing include site preparation, dredging production rates, available footprint for dewatering operations, disposal methods, and sequencing the dam removals. Table 5-7 lists preliminary estimated durations for the dredging, dewatering, and disposal construction operations for each impoundment.

Table 5-7: Preliminary Estimated Construction Duration for Sediment Removal

Impoundment	Sediment Volume to be dredged (yd^3)	Mob/Demob and Site Preparation* (months)	Dredging (months)	Dewatering and Disposal lag after Dredging (months)	Site Restoration (months)	Sediment Removal Duration (months)
Aluminum City	1,304	1-3	3-6	1-2	1	6-12
Allen Street	2,237	2-4	1-2	1-2	1	5-9
Hudson	71,558	2-4	8-16	1-3	2	13-25
Gleasondale	27,856	2-4	4-12	1-2	2	9-20
Ben Smith	67,601	2-4	9-18	1-3	2	14-27
Powdermill	65,833	2-4	9-18	1-3	2	14-27

**Mobilization and Demobilization of construction equipment required for dredging and dewatering operations.*

5.3.1 Aluminum City Impoundment

For the Aluminum City impoundment, site preparation would include setting up for mechanical dredging operations. With maximum water depths of 3.5 feet and channel widths of 30 to 65 feet, it may be possible to access the impoundment with low pressure backhoes and similar excavating equipment. As suggested previously, if the Aluminum City dam can be removed in controlled increments, the water level in the impoundment can be lowered which would allow standard ground equipment to access the impoundment. Additional site preparation includes removing oversized debris around the dam and any other areas, clearing and grubbing, establishing access and haul roads, and preparing the dewatering area.

The dredging estimate is shown in Table 5-7 and is based on mechanical dredging of the impoundment sediment. A 1 to 2 month lag in dewatering and disposal may be estimated based on the amount of water to be treated, time to dewater and solidify/bulk the sediment, and time to haul the sediment off site. Site restoration would include removal of dewatering areas, haul roads, water treatment equipment, and restoration of any river banks or areas that were impacted by the construction.

Sediment in the Aluminum City impoundment may be dredged and disposed of in one to two construction seasons.

5.3.2 Allen Street Impoundment

For the Allen Street impoundment, site preparation would include setting up for hydraulic dredging operations, including performing a pilot study prior to full scale production. Additional site preparation includes removing oversized debris around the dam and any other areas, clearing and grubbing, establishing access and haul roads, and preparing the dewatering area.

The dredging estimate is shown in Table 5-7 and is based on hydraulic dredging using relatively small (500 gpm) equipment. If it is not possible to reach the river banks using hydraulic dredge equipment, then as suggested previously, another option would be to remove the Allen Street dam in controlled increments. This would lower the water level, which would allow standard ground equipment to access the impoundment. A 1 to 2 month lag in dewatering and disposal may be estimated based on the amount of water to be treated, time to dewater and solidify/bulk the sediment, and time to haul the sediment off site. Site restoration would include removal of dewatering areas, haul roads, water treatment equipment, and restoration of any river banks or areas that were impacted by the construction.

Sediment in the Allen Street impoundment may be dredged and disposed of in one construction season.

5.3.3 Hudson Impoundment

For the Hudson impoundment, site preparation would include setting up for hydraulic dredging operations, including performing a pilot study prior to full scale production. Additional site preparation includes removing oversized debris around the dam and any other areas, clearing and grubbing, establishing access and haul roads, and preparing the dewatering area.

The dredging estimate is shown in Table 5-7 and is based on hydraulic dredging. If it is not possible to reach the river banks using hydraulic dredge equipment, then as suggested previously, another option would be to remove the Hudson dam in controlled increments. This would lower the water level which would allow standard ground equipment to access the impoundment. A 1 to 3 month lag in dewatering and disposal may be estimated based on the amount of water to be treated, time to dewater and solidify/bulk the sediment, and time to haul the sediment off site. Site restoration would include removal of dewatering areas, haul roads, water treatment equipment, and restoration of any river banks or areas that were impacted by the construction.

Sediment in the Hudson impoundment may be dredged and disposed of in two to three construction seasons.

5.3.4 Gleasondale Impoundment

For the Gleasondale impoundment, site preparation would include setting up for hydraulic dredging operations, including performing a pilot study prior to full scale production. Additional site preparation includes removing oversized debris around the dam and any other areas, clearing and grubbing, establishing access and haul roads, and preparing the dewatering area.

The dredging estimate is shown in Table 5-7 and is based on hydraulic dredging. If it is not possible to reach the river banks using hydraulic dredge equipment, then as suggested previously, another option would be to remove the Gleasondale dam in controlled increments. This would lower the water level which would allow standard ground equipment to access the impoundment. A 1 to 2 month lag in dewatering and disposal may be estimated based on the amount of water to be treated, time to dewater and solidify/bulk the sediment, and time to haul the sediment off site. Site restoration would include removal of dewatering areas, haul roads, water treatment equipment, and restoration of any river banks or areas that were impacted by the construction.

Sediment in the Gleasondale impoundment may be dredged and disposed of in one to two construction seasons.

5.3.5 Ben Smith Impoundment

For the Ben Smith impoundment, site preparation would include setting up for hydraulic dredging operations, including performing a pilot study prior to full scale production. Additional site preparation includes removing oversized debris around the dam and any other areas, clearing and grubbing, establishing access and haul roads, and preparing the dewatering area.

The dredging estimate is shown in Table 5-7 and is based on hydraulic dredging. If it is not possible to reach the river banks using hydraulic dredge equipment, then as suggested previously, another option would be to remove the Ben Smith dam in controlled increments. This would lower the water level which would allow standard ground equipment to access the impoundment. A 1 to 3 month lag in dewatering and disposal may be estimated based on the amount of water to be treated, time to dewater and solidify/bulk the sediment, and time to haul the sediment off site. Site restoration would include removal of dewatering areas, haul roads, water treatment equipment, and restoration of any river banks or areas that were impacted by the construction.

Sediment in the Ben Smith impoundment may be dredged and disposed of in two to three construction seasons.

5.3.6 Powdermill Impoundment

For the Powdermill impoundment, site preparation would include setting up for hydraulic dredging operations, including performing a pilot study prior to full scale production. Additional site preparation includes removing oversized debris around the dam and any other areas, clearing and grubbing, establishing access and haul roads, and preparing the dewatering area.

The dredging estimate is shown in Table 5-7 and is based on hydraulic dredging. If it is not possible to reach the river banks using hydraulic dredge equipment, then as suggested previously, another option would be to remove the Powdermill dam in controlled increments. This would lower the water level which would allow standard ground equipment to access the impoundment. A 1 to 3 month lag in dewatering and disposal may be estimated based on the amount of water to be treated, time to dewater and solidify/bulk the sediment, and time to haul the sediment off site. Site restoration would include removal of dewatering areas, haul roads, water treatment equipment, and restoration of any river banks or areas that were impacted by the construction.

Sediment in the Powdermill impoundment may be dredged and disposed of in two to three construction seasons.

Attachment 1
USGS 2003 Sediment Sampling Results

2003 USGS Sediment Studies in the Assabet River - Analytical Results for Metals (mg/kg)

Impoundment	Location ID	Sample ID	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
Aluminum City	AC1	5	5	1	145	309	85	22	183
Aluminum City	AC2	7A	9	2	96	256	74	22	249
Aluminum City	AC2	7B	9	3	124	768	182	28	397
Aluminum City	AC2	7C	7	1	171	189	67	18	155
Aluminum City	AC3	6A	10	2	145	286	95	22	278
Aluminum City	AC3	6B	16	4	174	844	180	30	495
Aluminum City	AC3	6C	15	2	183	362	238	24	296
Aluminum City	AC4	8A	12	2	103	262	65	24	223
Aluminum City	AC4	8B	7	2	153	502	78	24	291
Aluminum City	AC4	8C	6	3	2070	196	65	31	1220
Allen Street	AS5	1A	8	1	177	42.9	84	17	211
Allen Street	AS5	1B	11	1	209	55.3	149	14	184
Allen Street	AS5	1C	10	1	85	44.8	113	16	136
Allen Street	AS5	1D	6	1	97	25.5	143	16	83.4
Allen Street	AS6	3A	11	4	142	515	229	33	487
Allen Street	AS6	3B	16	1	224	53.7	150	19	182
Allen Street	AS6	3C	7	1	149	16.9	58	17	78.3
Allen Street	AS7	2A	13	3	340	110	241	30	827
Allen Street	AS7	2B	11	3	242	59.2	146	18	474
Allen Street	AS7	2C	12	2	137	60.4	154	17	351
Allen Street	AS7	2D	8	1	128	29.6	185	19	87.3
Allen Street	AS8	4A	12	2	152	188	90	24	281
Allen Street	AS8	4B	11	4	208	807	176	31	551
Allen Street	AS8	4C	12	3	158	300	201	27	515
Allen Street	AS8	4D	14	1	155	51.5	110	23	221
Allen Street	AS8	4E	9	1	90	18	218	15	54
Ben Smith	BS28	16A	9	1	157	23.2	30	20	82.8
Ben Smith	BS28	16B	8	1	195	11.4	15	15	50.1
Ben Smith	BS29	18A	7	1	157	19.2	26	14	43.9
Ben Smith	BS29	18B	6	1	100	5.4	13	9	5.7
Ben Smith	BS29	18C	5	1	174	3.5	12	16	9.8
Ben Smith	BS30	17A	24	7	293	201	204	98	515
Ben Smith	BS30	17B	52	3	250	118	188	31	617
Ben Smith	BS30	17C	64	3	353	128	179	31	637
Ben Smith	BS30	17D	18	1	241	102	95	23	165
Ben Smith	BS30	17E	3	1	79	5.8	10	8	3.2
Ben Smith	BS31	19A	82	2	397	121	178	32	479
Ben Smith	BS31	19B	35	1	298	167	166	29	281
Ben Smith	BS31	19C	17	1	210	72.6	74	23	112
Ben Smith	BS31	19D	5	1	197	7.5	9	20	21.6
Ben Smith	BS31	19E	6	1	236	8.3	6	22	16.8
Ben Smith	BS32	20A	17	7	170	318	192	132	492
Ben Smith	BS32	20B	35	5	173	124	263	36	481
Ben Smith	BS32	20C	6	1	116	14.8	12	16	34.4
Ben Smith	BS32	20D	6	1	48	9.4	6	12	23
Ben Smith	BS32	20E	9	1	165	10.6	6	19	29.8
Ben Smith	BS33	21A	35	2	179	123	144	26	334
Ben Smith	BS33	21B	8	1	85	14.4	20	16	30.9
Ben Smith	BS33	21C	4	1	85	7.5	8	14	21.6
Ben Smith	BS33	21D	4	1	132	8.9	7	17	25.1
Ben Smith	BS33	21E	3	1	151	8.3	6	16	26.6
Ben Smith	BS34	22A	34	7	249	175	213	59	484
Ben Smith	BS34	22B	9	1	195	15.4	18	15	38.3
Ben Smith	BS34	22C	3	1	94	6.6	7	14	19.4
Ben Smith	BS35	23A	39	3	175	116	160	47	446
Ben Smith	BS35	23B	61	2	213	101	164	27	458
Ben Smith	BS35	23C	11	1	135	18.9	72	15	37.5
Ben Smith	BS36	27A	8	1	58	3.9	10	14	26.4

2003 USGS Sediment Studies in the Assabet River - Analytical Results for Metals (mg/kg)

Impoundment	Location ID	Sample ID	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
Ben Smith	BS36	27B	19	1	176	4	10	18	27.8
Ben Smith	BS36	27C	55	1	88	3.2	12	18	26.8
Ben Smith	BS36	27D	82	1	54	2.7	11	14	24.2
Ben Smith	BS37	29A	17	1	152	23.2	32	16	62.2
Ben Smith	BS37	29B	8	1	99	2.2	10	12	18.4
Ben Smith	BS37	29C	4	1	130	1.7	11	13	18.7
Ben Smith	BS38	26A	71	4	160	131	3800	46	483
Ben Smith	BS38	26B	59	2	245	122	160	28	390
Ben Smith	BS38	26C	19	1	167	67.8	80	22	110
Ben Smith	BS38	26D	11	1	147	5.8	13	23	13.7
Ben Smith	BS38	26E	9	1	75	5.1	10	28	44.6
Ben Smith	BS39	25A	17	1	184	13.6	25	25	53.7
Ben Smith	BS39	25B	11	1	246	11.1	11	26	29
Ben Smith	BS40	24A	14	1	216	13.4	16	27	36.9
Ben Smith	BS40	24B	8	1	130	3.5	8	17	23.8
Ben Smith	BS40	24C	14	1	151	4.6	9	25	27
Ben Smith	BS41	28A	14	1	237	4.5	8	18	23.4
Ben Smith	BS41	28B	83	1	91	2.7	14	18	22.3
Ben Smith	BS42	33A	12	1	239	38.6	50	21	81.1
Ben Smith	BS42	33B	10	1	383	41.2	29	19	43.4
Ben Smith	BS43	30A	21	5	132	167	160	68	386
Ben Smith	BS43	30B	41	4	182	117	157	47	422
Ben Smith	BS43	30C	36	1	167	94.2	125	22	213
Ben Smith	BS43	30D	19	1	140	21.4	32	17	47
Ben Smith	BS43	30E	8	1	94	2.8	11	11	13.3
Ben Smith	BS44	31A	6	1	254	5.5	5	12	16.6
Ben Smith	BS44	31B	5	1	271	11.7	18	11	22.6
Ben Smith	BS45	32A	3	1	180	3.8	3	11	14.9
Ben Smith	BS45	32B	4	1	228	10.3	8	14	18.9
Gleasondale	G16	34A	4	1	77	7.2	16	12	18.6
Gleasondale	G16	34B	3	1	127	8	13	16	32.1
Gleasondale	G16	34C	3	1	114	3.5	8	17	27.6
Gleasondale	G17	39A	5	1	173	8.2	6	16	29.2
Gleasondale	G17	39B	3	1	158	7.6	4	15	22.3
Gleasondale	G17	39C	6	1	155	9.5	4	16	28.5
Gleasondale	G17	39D	6	1	191	8.2	3	17	24.3
Gleasondale	G18	35A	34	3	404	115	186	33	369
Gleasondale	G18	35B	32	2	203	111	221	23	484
Gleasondale	G18	35C	46	1	313	122	186	22	315
Gleasondale	G18	35D	19	1	99	125	141	18	262
Gleasondale	G18	35E	17	1	333	128	125	22	180
Gleasondale	G19	40A	19	12	326	261	254	91	464
Gleasondale	G19	40B	75	3	195	162	232	26	518
Gleasondale	G19	40C	50	2	257	144	198	24	358
Gleasondale	G19	40D	7	1	237	72	69	19	101
Gleasondale	G19	40E	3	1	209	5.6	4	12	19.6
Gleasondale	G20	36A	7	1	125	8.7	9	15	31.4
Gleasondale	G20	36B	5	1	118	7	6	14	24.2
Gleasondale	G20	36C	3	1	125	7.7	5	15	38.7
Gleasondale	G20	36D	10	1	112	13.2	6	18	31.2
Gleasondale	G20	36E	41	1	39	38.8	5	28	93.8
Gleasondale	G21	44	8	1	373	24.8	30	22	71
Gleasondale	G22	41A	17	7	284	405	233	149	485
Gleasondale	G22	41B	20	3	367	102	145	44	248
Gleasondale	G22	41C	14	1	409	81.6	87	22	142
Gleasondale	G23	37A	3	1	219	10.2	17	15	31.7
Gleasondale	G23	37B	7	1	246	9.2	12	13	36.8
Gleasondale	G23	37C	5	1	192	17.7	23	13	47.6
Gleasondale	G23	37D	14	1	286	153	147	23	191
Gleasondale	G24	42A	14	1	101	7.1	20	17	33.7
Gleasondale	G24	42B	9	1	149	4.6	9	17	25.3
Gleasondale	G25	45	5	1	223	7	9	11	23.7
Gleasondale	G26	38A	11	1	64	7.9	11	9	15
Gleasondale	G26	38B	16	1	96	10.7	8	9	15.9
Gleasondale	G26	38C	16	1	194	7.8	4	24	34.2
Gleasondale	G27	43	7	1	295	33.3	66	24	84.2

2003 USGS Sediment Studies in the Assabet River - Analytical Results for Metals (mg/kg)

Impoundment	Location ID	Sample ID	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
Hudson	H10	12A	15	2	104	119	324	41	212
Hudson	H10	12B	20	2	130	78.9	243	24	300
Hudson	H10	12C	8	1	114	92.6	118	22	122
Hudson	H10	12D	5	1	28	8.2	8	8	14.6
Hudson	H10	12E	9	1	54	14.4	9	12	16
Hudson	H11	13A	24	1	228	131	129	38	288
Hudson	H11	13B	8	1	164	7.2	12	14	19.4
Hudson	H11	13C	27	1	93	5.9	9	22	38.7
Hudson	H11	13D	38	1	111	5.4	9	33	62.7
Hudson	H12	11A	4	1	155	7	6	20	28.1
Hudson	H12	11B	3	1	186	3.3	3	14	18.9
Hudson	H13	14A	14	3	161	120	266	57	410
Hudson	H13	14B	21	2	213	67.4	274	36	422
Hudson	H13	14C	9	1	304	22.9	146	29	66.1
Hudson	H13	14D	5	1	220	7.6	5	14	12.7
Hudson	H13	14E	3	1	144	4.3	4	11	16.2
Hudson	H14	10A	9	1	237	27.3	20	32	77
Hudson	H14	10B	5	1	134	4.1	6	12	20.7
Hudson	H15	15A	20	2	208	141	283	86	406
Hudson	H15	15B	25	1	193	96.1	218	29	365
Hudson	H15	15C	17	1	159	40.3	65	22	69
Hudson	H15	15D	101	1	85	3.4	20	11	21.8
Hudson	H9	9	8	1	129	12.7	12	14	35
Powdermill	P46	48	21	2	899	280	233	40	289
Powdermill	P47	49	8	1	394	50.9	110	30	152
Powdermill	P48	46A	34	1	1290	257	259	26	162
Powdermill	P48	46B	20	1	238	31.6	23	31	75.2
Powdermill	P48	46C	62	1	129	17.2	11	45	47
Powdermill	P49	47	5	1	268	19.4	58	27	59.3
Powdermill	P50	52A	15	2	272	109	231	54	331
Powdermill	P50	52B	13	2	339	123	261	77	298
Powdermill	P50	52C	11	1	311	78.3	244	41	183
Powdermill	P50	52D	22	4	478	128	174	35	306
Powdermill	P50	52E	36	1	291	55	318	20	93.2
Powdermill	P51	55A	31	5	1060	839	594	60	1140
Powdermill	P51	55B	58	3	1830	386	343	24	1010
Powdermill	P51	55C	3	1	97	22.4	12	51	10.8
Powdermill	P51	55D	6	1	128	40	7	52	17.5
Powdermill	P52	53A	16	2	399	100	167	56	354
Powdermill	P52	53B	13	4	404	184	371	53	339
Powdermill	P52	53C	101	7	2270	330	621	29	726
Powdermill	P52	53D	20	1	421	194	115	21	163
Powdermill	P52	53E	10	1	302	26.8	71	25	44.8
Powdermill	P53	56A	18	6	416	669	580	272	379
Powdermill	P53	56B	47	4	1550	277	515	54	424
Powdermill	P53	56C	66	8	1970	545	419	26	1010
Powdermill	P54	54A	44	7	1530	3430	1030	69	905
Powdermill	P54	54B	6	1	148	49.8	29	14	388
Powdermill	P54	54C	3	1	106	14.6	14	10	62.6
Powdermill	P55	51A	9	1	248	78	54	46	99.6
Powdermill	P55	51B	6	1	179	10.5	11	21	33.2
Powdermill	P55	51C	9	1	173	6.2	7	22	31.4
Powdermill	P55	51D	6	1	274	5.5	7	29	28.7
Powdermill	P55	51E	4	1	240	5.9	7	30	29.3
Powdermill	P56	50A	17	6	332	720	411	179	572
Powdermill	P56	50B	28	10	786	910	1250	84	1200
Powdermill	P56	50C	48	9	1320	459	305	28	703
Powdermill	P56	50D	9	1	187	23.7	40	26	48.2
Powdermill	P56	50E	3	1	221	9.1	7	13	10.3
Powdermill	P57	57	3	1	272	18	45	30	66.9

2003 USGS Sediment Studies in the Assabet River - Analytical Results for Organic Compounds (mg/kg)

Impoundment	Location ID	Sample ID	PCB	PAH	EPHC
Aluminum City	AC1	5	0.249	3.3	400
Aluminum City	AC2	7	0.443	3.2	570
Aluminum City	AC3	6	0.516	2.7	530
Aluminum City	AC4	8A	0.228	5.5	460
Aluminum City	AC4	8B	0.2952	1.7	610
Aluminum City	AC4	8C	0.0499	0.72	320
Allen Street	AS5	1	0	58	1480
Allen Street	AS6	3	0.214	6.8	420
Allen Street	AS7	2A	0.332	16	720
Allen Street	AS7	2B	0	21	540
Allen Street	AS7	2C	0	4.5	1060
Allen Street	AS8	4	0.0635	8.2	770
Hudson	H9	9	0	0.19	400
Hudson	H10	12	0	77	470
Hudson	H10	12Q	0	70	
Hudson	H11	13	0	2.1	340
Hudson	H12	11A	0	0.13	340
Hudson	H12	11B	0	0.082	330
Hudson	H13	14A	0	67	460
Hudson	H13	14AQ	0	61	
Hudson	H13	14B	0	30	360
Hudson	H13	14BQ	0	40	
Hudson	H13	14C	0	0.013	300
Hudson	H13	14CQ	0	0.04	
Hudson	H14	10	0	0.082	340
Hudson	H15	15	0	12	300
Gleasondale	G16	34	0	0.28	330
Gleasondale	G17	39	0	3.2	300
Gleasondale	G18	35A	3.1	99	2640
Gleasondale	G18	35B	0	75	750
Gleasondale	G18	35C	0	11	560
Gleasondale	G19	40A	1.96	10	930
Gleasondale	G19	40B	1.28	35	1990
Gleasondale	G19	40C	0	2.7	370
Gleasondale	G19	40CQ	0	3.7	
Gleasondale	G20	36	0	0.18	520
Gleasondale	G20	36Q	0	0.18	
Gleasondale	G21	44	0.0672	1.8	360
Gleasondale	G22	41	0.333	17	710
Gleasondale	G23	37	0	2.4	550
Gleasondale	G24	42	0.626	3.2	370
Gleasondale	G25	45	0.254	1	300
Gleasondale	G26	38	0	2.8	820
Gleasondale	G27	43	0.16	2.8	300

Impoundment	Location ID	Sample ID	PCB	PAH	EPHC
Ben Smith	BS28	16	0.149	0.26	300
Ben Smith	BS29	18	0	0.33	470
Ben Smith	BS30	17A	1.55	31	960
Ben Smith	BS30	17B	0	13	620
Ben Smith	BS30	17C	0	0.039	540
Ben Smith	BS31	19A	0	0.09	1180
Ben Smith	BS31	19AQ	0	0.024	
Ben Smith	BS31	19B	0	2.9	740
Ben Smith	BS31	19BQ	0	2.4	
Ben Smith	BS31	19C	0.332	26	630
Ben Smith	BS31	19CQ	0.352	21	
Ben Smith	BS32	20A	0.465	7.3	1660
Ben Smith	BS32	20B	0	0.5	950
Ben Smith	BS32	20C	0	0.15	990
Ben Smith	BS33	21	0.793	5.8	800
Ben Smith	BS34	22	0.749	5.2	790
Ben Smith	BS35	23	0.258	1.2	980
Ben Smith	BS36	27	0	0.11	300
Ben Smith	BS37	29	0	0.089	320
Ben Smith	BS38	26A	0	11	610
Ben Smith	BS38	26B	0	0.7	410
Ben Smith	BS38	26C	0	0	310
Ben Smith	BS39	25	0	0.53	580
Ben Smith	BS40	24	0.077	3.5	510
Ben Smith	BS41	28	0	0	300
Ben Smith	BS42	33	0.136	1.2	410
Ben Smith	BS43	30A	1.61	9.6	570
Ben Smith	BS43	30B	0.212	5.7	440
Ben Smith	BS43	30C	0	0.07	300
Ben Smith	BS44	31	0	0.045	310
Ben Smith	BS45	32	0.0578	0.33	330
Powdermill	P46	48	0.208	48	1540
Powdermill	P46	48Q	0.177	50	
Powdermill	P47	49	0.253	40	630
Powdermill	P48	46A	0	0.0072	300
Powdermill	P48	46B	0	5.2	320
Powdermill	P48	46C	0.846	65	1860
Powdermill	P49	47	0	7.7	550
Powdermill	P50	52	0	1100	1600
Powdermill	P51	55	0	21	2230
Powdermill	P52	53	0	180	890
Powdermill	P53	56	0	96	1810
Powdermill	P54	54A	0	99	4380
Powdermill	P54	54B	0	5.3	2260
Powdermill	P54	54C	0	1.2	740
Powdermill	P55	51A	0	12	300
Powdermill	P55	51B	0	0.094	300
Powdermill	P55	51C	0	0.14	300
Powdermill	P56	50A	0.808	29	1320
Powdermill	P56	50AQ	1.28	4	
Powdermill	P56	50B	0.386	78	2320
Powdermill	P56	50C	0	1.5	300
Powdermill	P57	57	0	0.16	300

Attachment 2

USGS 2003 Sediment Sampling Locations

Figure A-1: USGS Sediment Sampling Locations
Aluminum City Impoundment
Assabet River

CDM
5/23/2008

Dredging Boundary
USGS Borings

0 25 50 100 Yards

Figure A-2: USGS Sediment Sampling Locations
Allen Street Impoundment
Assabet River

CDM

5/23/2008

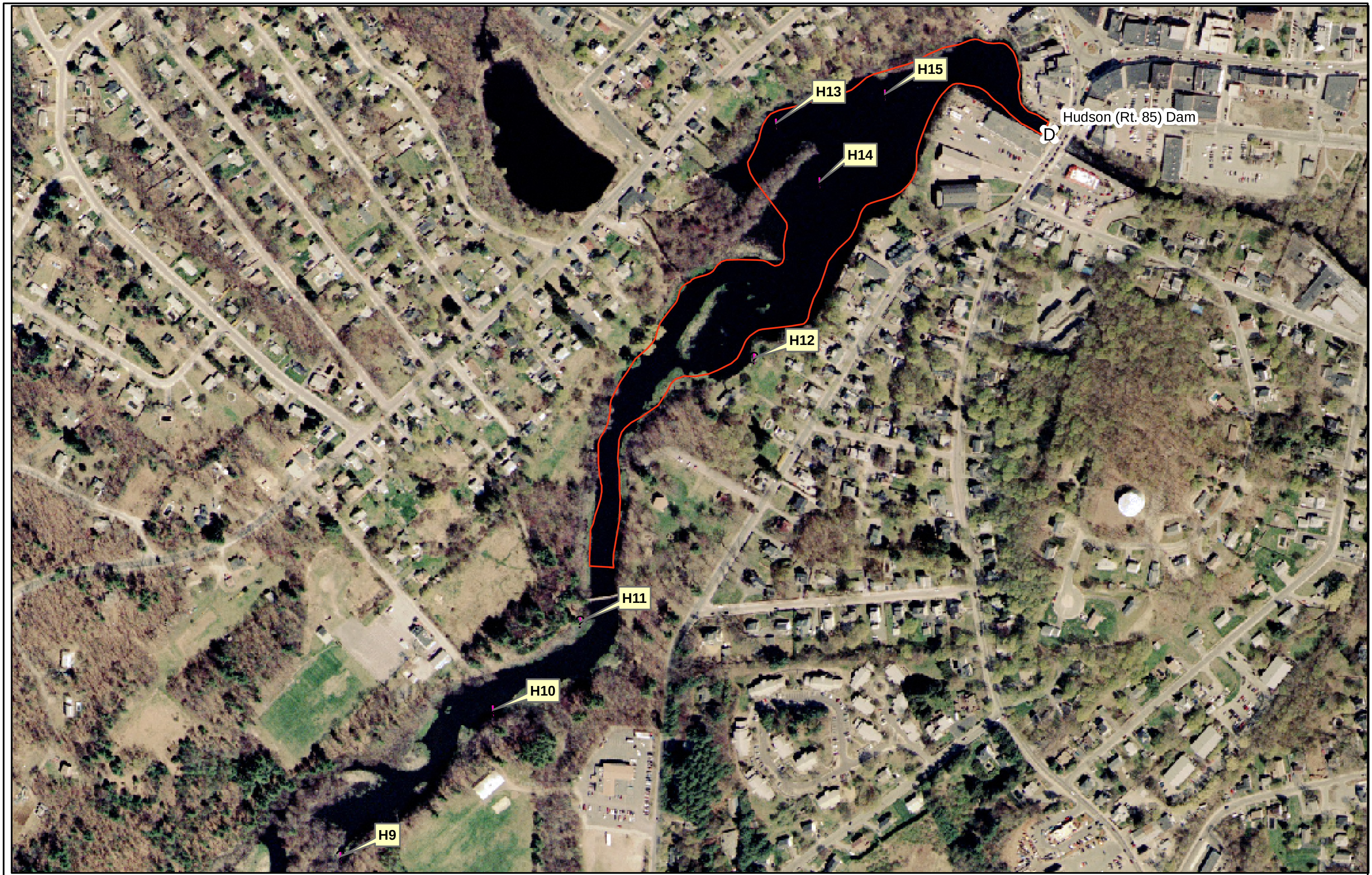

Figure A-3: USGS Sediment Sampling Locations
Hudson Impoundment
Assabet River

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0 100 200 400 Yards

Dredging Boundary

USGS Borings

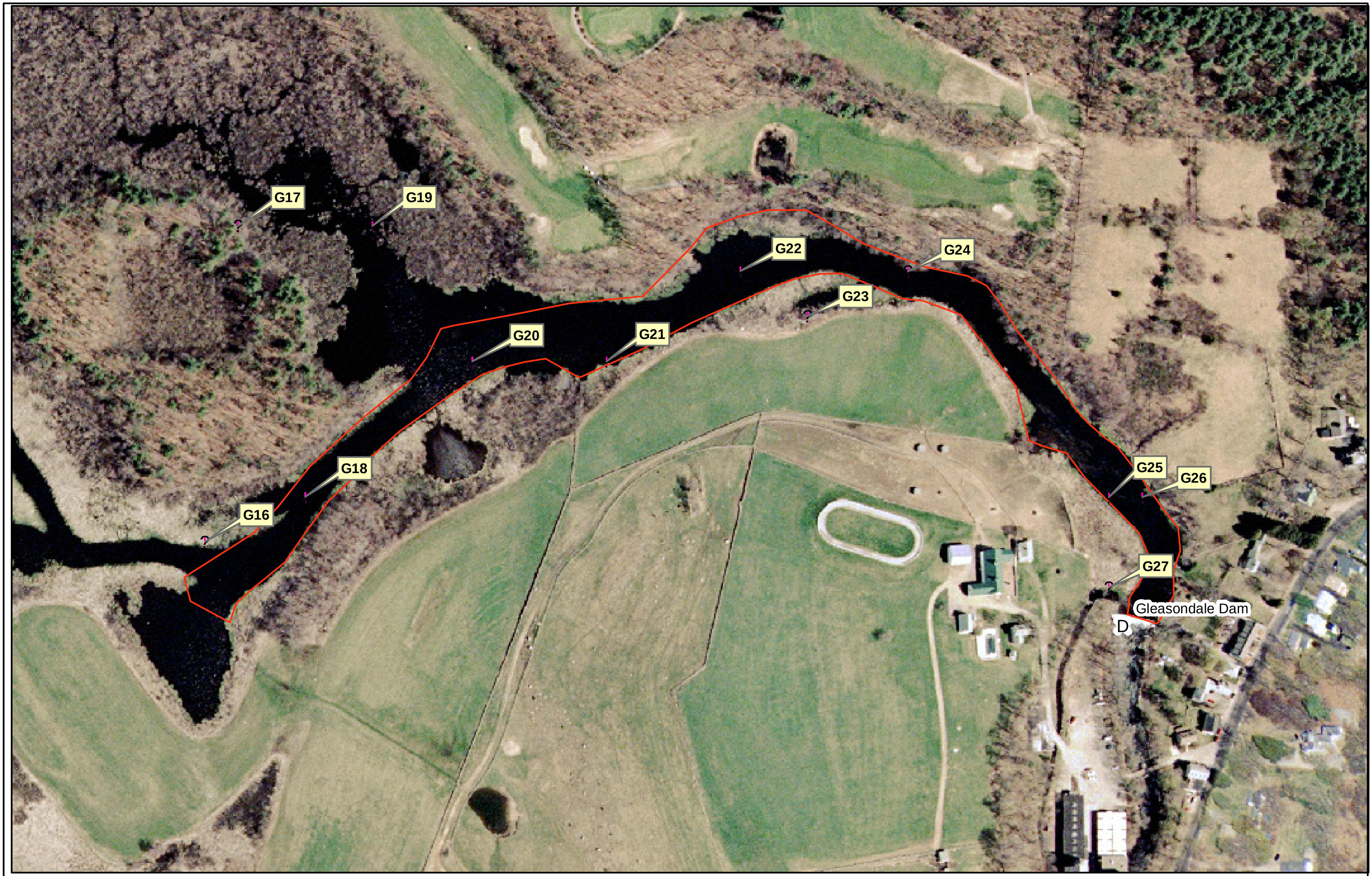
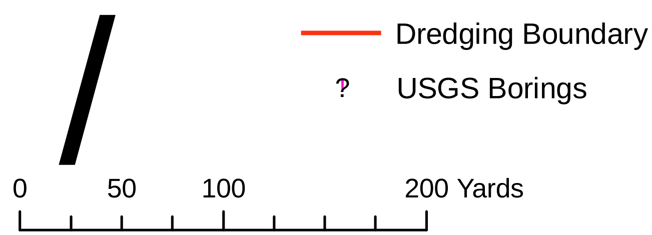


Figure A-4: USGS Sediment Sampling Locations
Gleasondale Impoundment
Assabet River



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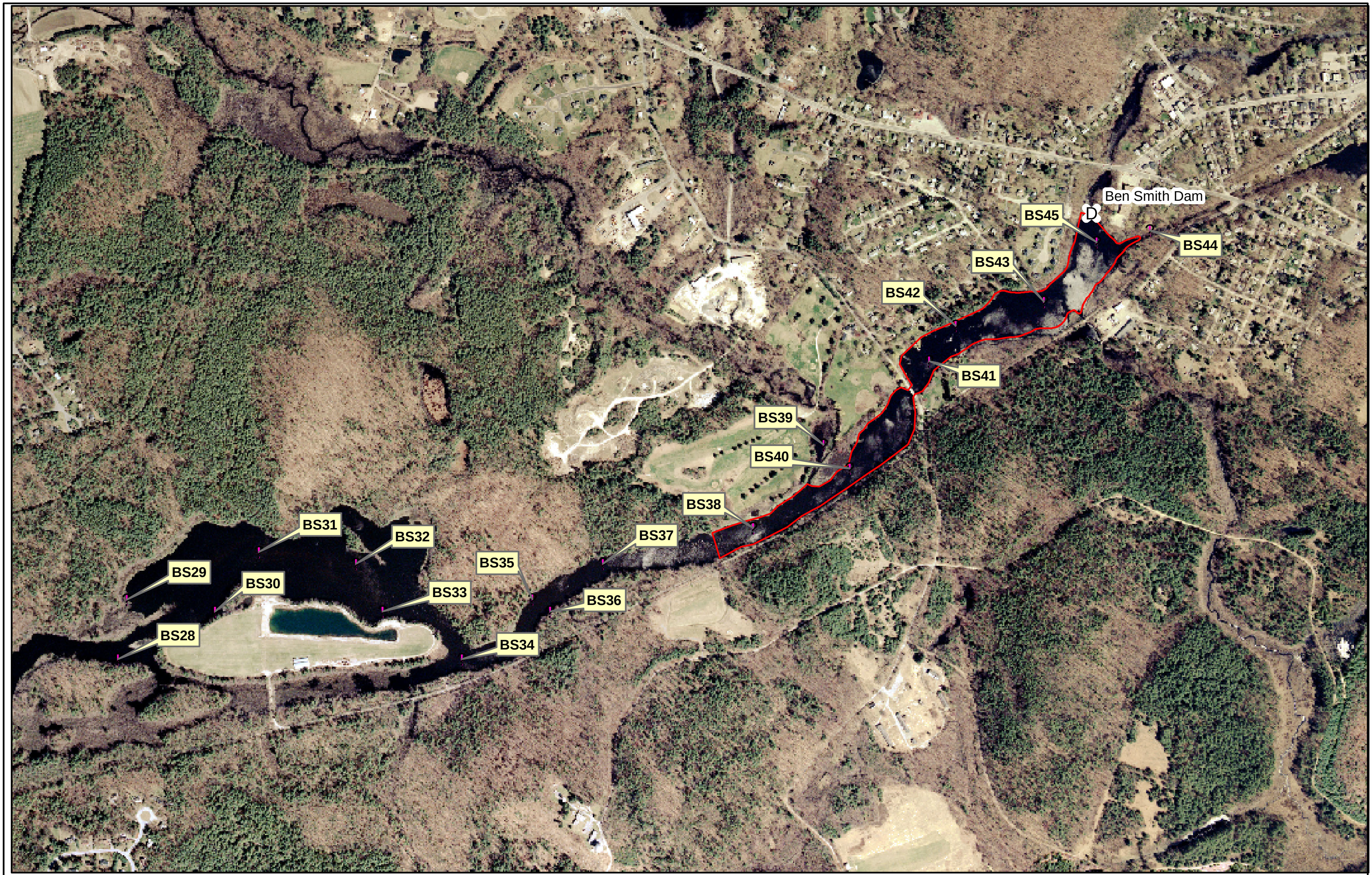

Figure A-5: USGS Sediment Sampling Locations
Ben Smith Impoundment
Assabet River

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Dredging Boundary
? USGS Borings

0 250 500 1,000 Yards

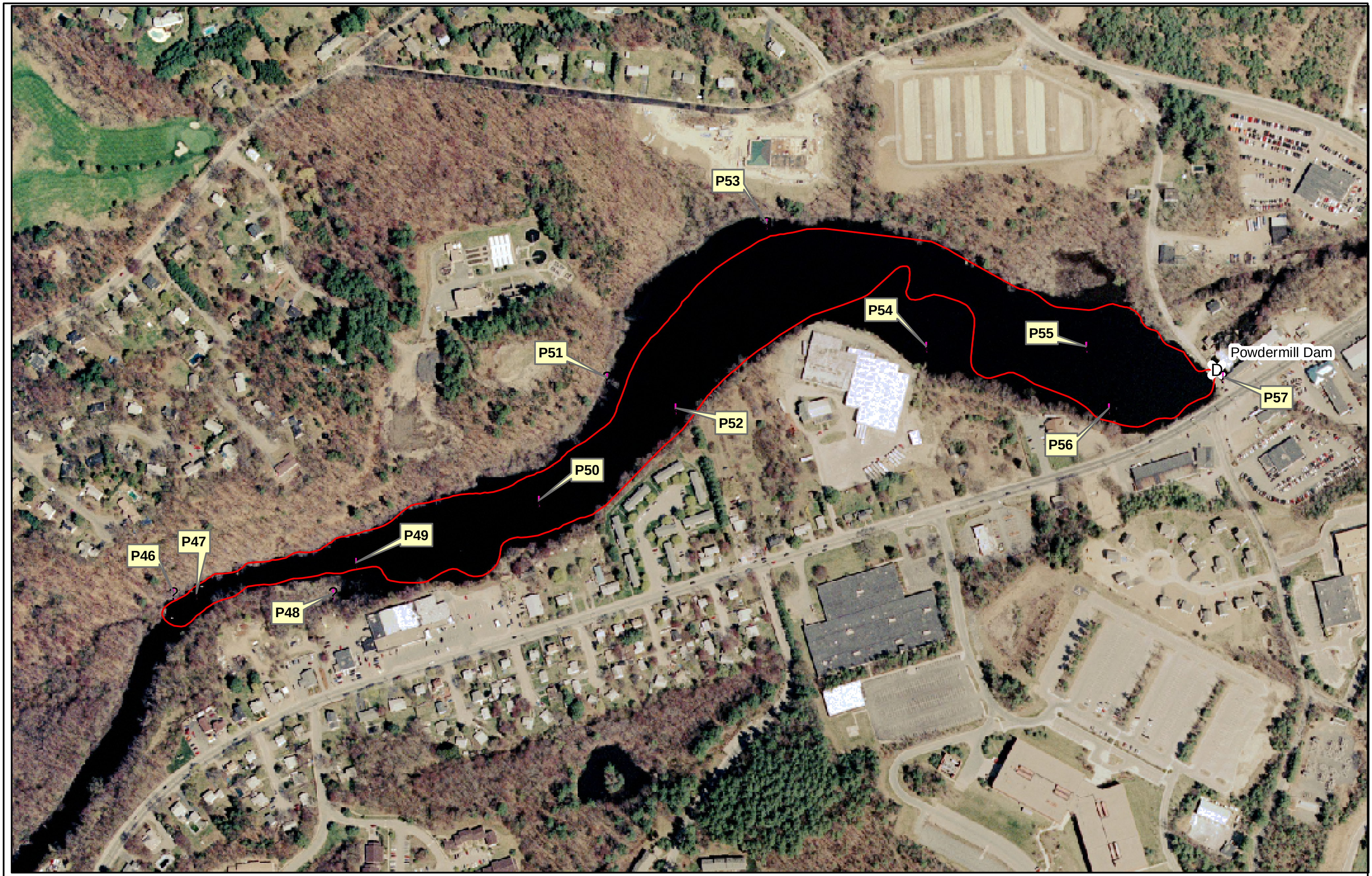


Figure A-6: USGS Sediment Sampling Locations
Powdermill Impoundment
Assabet River

CDM

5/23/2008

Attachment 3

2008 CDM Memorandum – Task 15 Sediment Removal Quantities

CDM

Memorandum

To: *Barbara Blumeris, USACE and Ken Chin, MA DEP*

From: *Ginger Croom, CDM*

Date: *February 13, 2008*

Subject: *Assabet River Sediment and Dam Removal Study, Task 15 Sediment Removal Quantities*

The purpose of this memorandum is to present the estimated sediment quantities to be removed as part of dam removal for the six study dams (Aluminum City, Allen Street, Hudson, Gleasondale, Ben Smith and Powdermill). The memo includes identification/delineation of areas where sediment should be removed along with the dam removal and planning-level estimates of the quantity of sediment to be removed for each dam. A brief discussion of the methodology for determining the sediment quantities is also discussed.

Sediment Removal Quantities

The sediment removal quantities associated with dam removal for the six study dams were calculated based on the results of the HEC-6 modeling conducted previously. A continuous simulation of channel bed profile was conducted as part of the HEC-6 modeling. Results of this simulation at different time steps (100 days, 200 days, 1-, 2-, 3-, 4- and 21-years) were plotted and the change in bed profile was analyzed over time. A comparison of the change in bed profile from the existing conditions and the post-dam removal scenarios was evaluated, and a constant slope methodology was applied to calculate the sediment quantity to be removed with each dam removal.

In general, applying the constant slope methodology allows for estimation of the sediment quantity that, if not removed as part of dam removal, would be transported downstream in a relatively short period of time following the dam removal. It is anticipated that this sediment quantity be removed and disposed of as part of the dam removal project. This methodology is used to develop estimated quantities for this planning level study, and is not intended as a basis for channel design.

Estimated sediment quantities associated with each dam removal are presented in Table 1. The sediment removal quantities and the methodology used in estimating the quantities were discussed with USACE staff on December 6, 2007. A follow-up meeting was held with USACE and MA DEP staff in Worcester on February 2.

Table 1. Estimated Sediment Quantities for Dam Removal

Dam	Sediment Removal Volume (yd^3)
Aluminum City	1,304
Allen St	2,237
Hudson	71,558
Gleasondale	27,856
Ben Smith	67,601
Powermill	65,833

The bed profiles for each impoundment area, including existing and after proposed dam removal are shown in Figures 1 through 7. The delineations of sediment removal for the Hudson, Gleasondale and Ben Smith dam removals are shown in Figures 8 through 10.

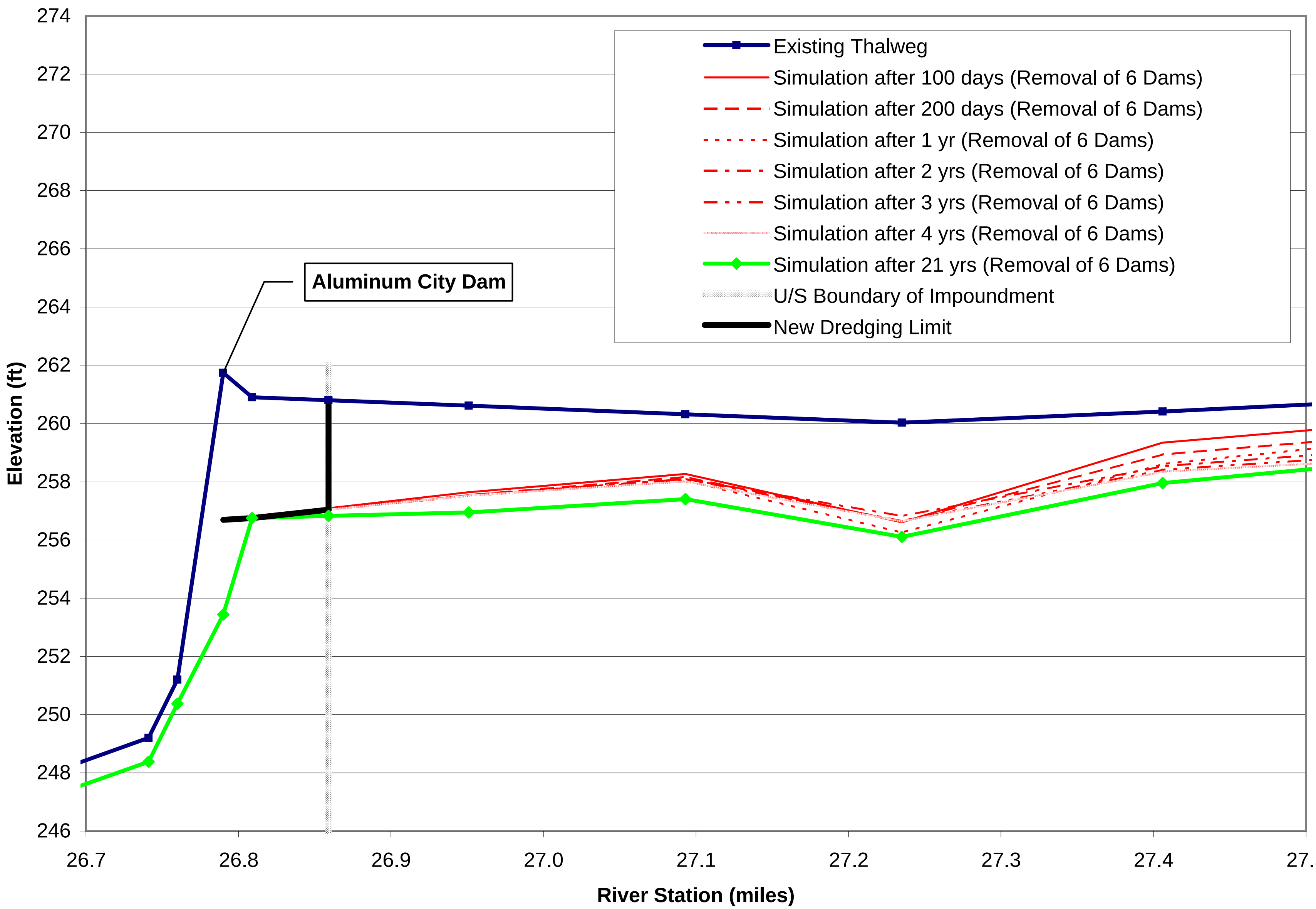

Existing Thalweg
Simulation after 100 days (Removal of 6 Dams)
Simulation after 200 days (Removal of 6 Dams)
Simulation after 1 yr (Removal of 6 Dams)
Simulation after 2 yrs (Removal of 6 Dams)
Simulation after 3 yrs (Removal of 6 Dams)
Simulation after 4 yrs (Removal of 6 Dams)
Simulation after 21 yrs (Removal of 6 Dams)
U/S Boundary of Impoundment
New Dredging Limit
Aluminum City Dam
Elevation (ft)
River Station (miles)
274
272
270
268
266
264
262
260
258
256
254
252
250
248
246
26.7
26.8
26.9
27.0
27.1
27.2
27.3
27.4
27.5

Figure 1

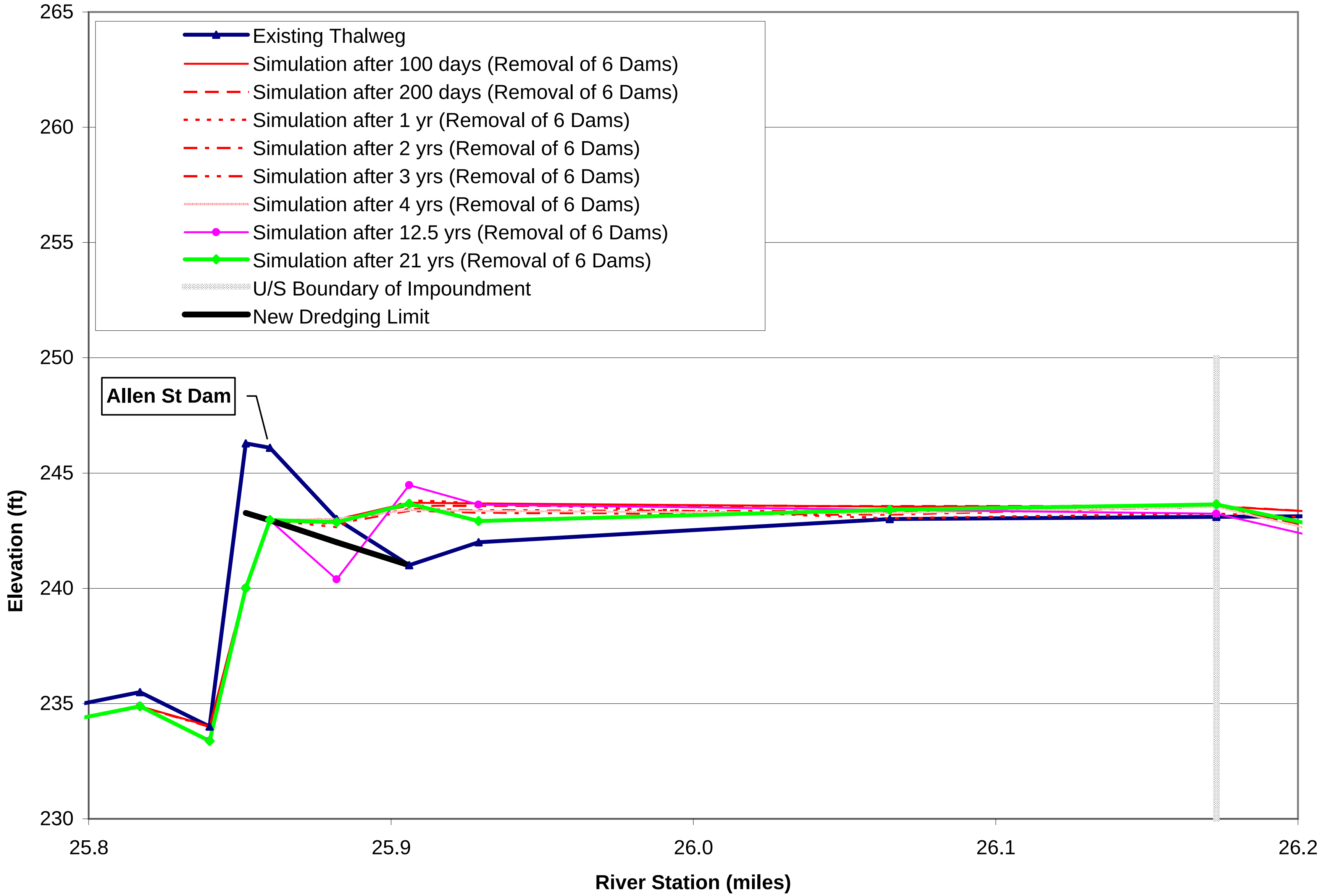
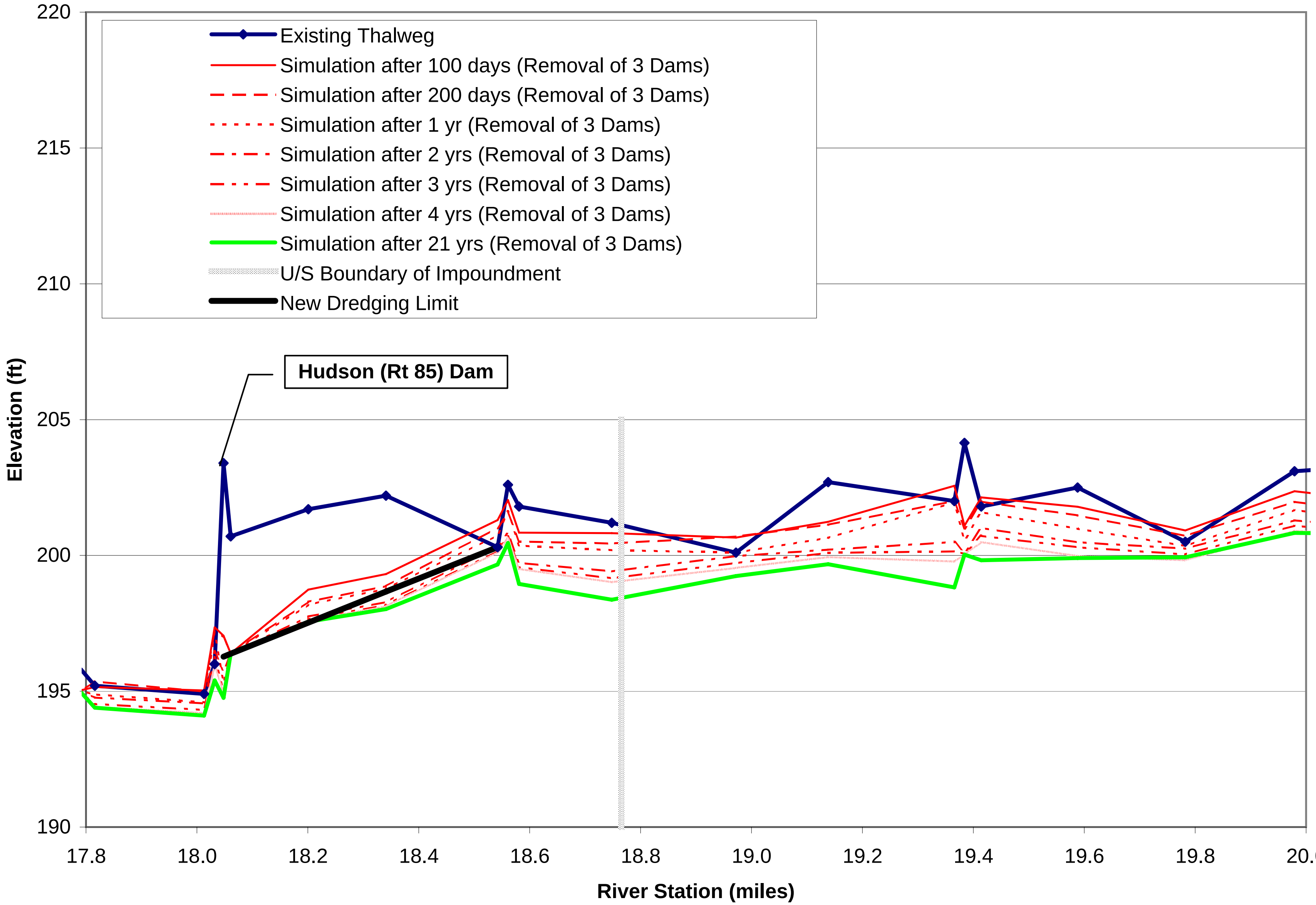
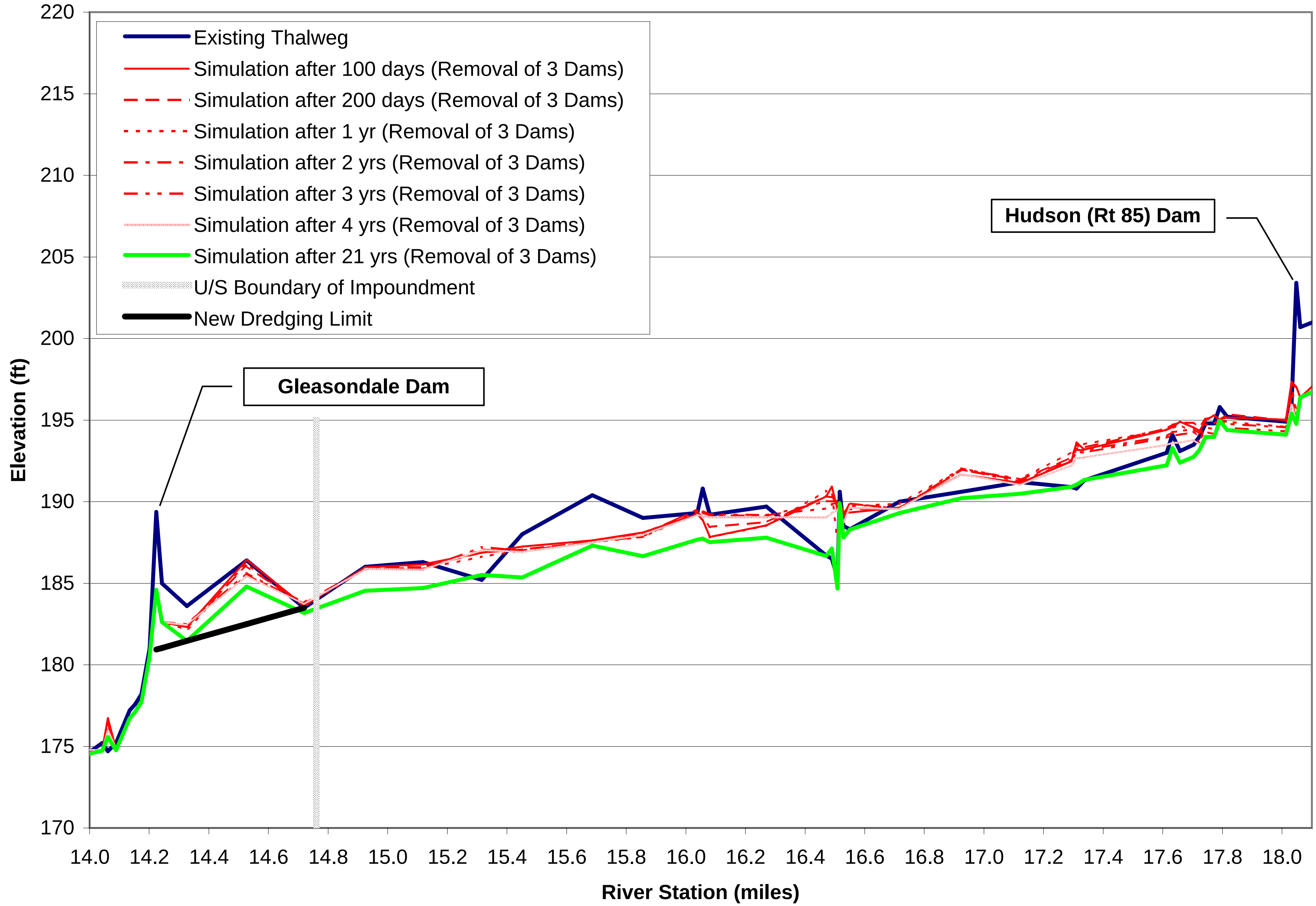

Existing Thalweg
Simulation after 100 days (Removal of 6 Dams)
Simulation after 200 days (Removal of 6 Dams)
Simulation after 1 yr (Removal of 6 Dams)
Simulation after 2 yrs (Removal of 6 Dams)
Simulation after 3 yrs (Removal of 6 Dams)
Simulation after 4 yrs (Removal of 6 Dams)
Simulation after 12.5 yrs (Removal of 6 Dams)
Simulation after 21 yrs (Removal of 6 Dams)
U/S Boundary of Impoundment
New Dredging Limit
Allen St Dam
Elevation (ft)
265
260
255
250
245
240
235
230
25.8
25.9
26.0
26.1
26.2
River Station (miles)

Figure 2



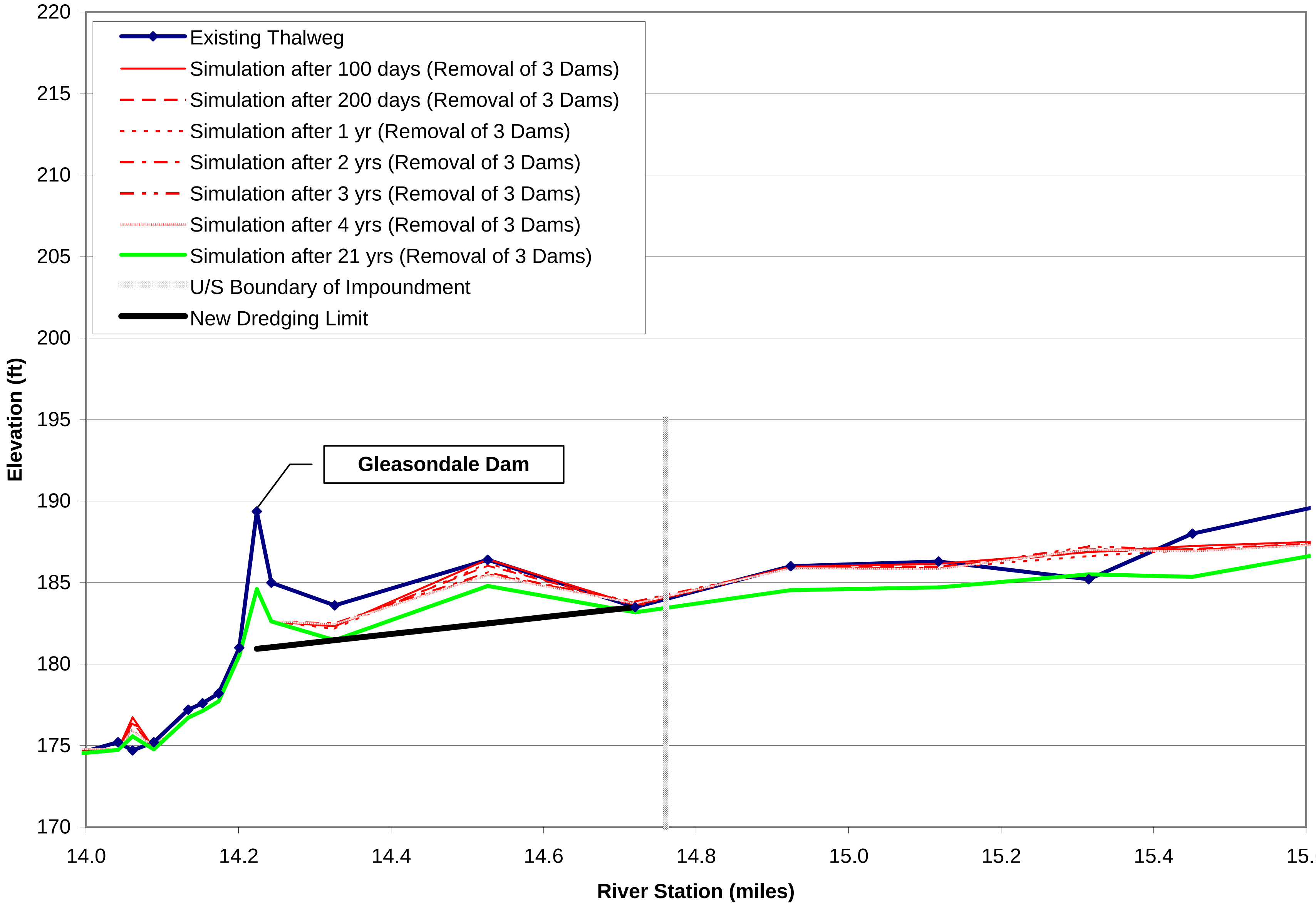
Existing Thalweg
Simulation after 100 days (Removal of 3 Dams)
Simulation after 200 days (Removal of 3 Dams)
Simulation after 1 yr (Removal of 3 Dams)
Simulation after 2 yrs (Removal of 3 Dams)
Simulation after 3 yrs (Removal of 3 Dams)
Simulation after 4 yrs (Removal of 3 Dams)
Simulation after 21 yrs (Removal of 3 Dams)
U/S Boundary of Impoundment
New Dredging Limit
Hudson (Rt 85) Dam
Elevation (ft)
220
215
210
205
200
195
190
17.8
18.0
18.2
18.4
18.6
18.8
19.0
19.2
19.4
19.6
19.8
20.0
River Station (miles)

Figure 3



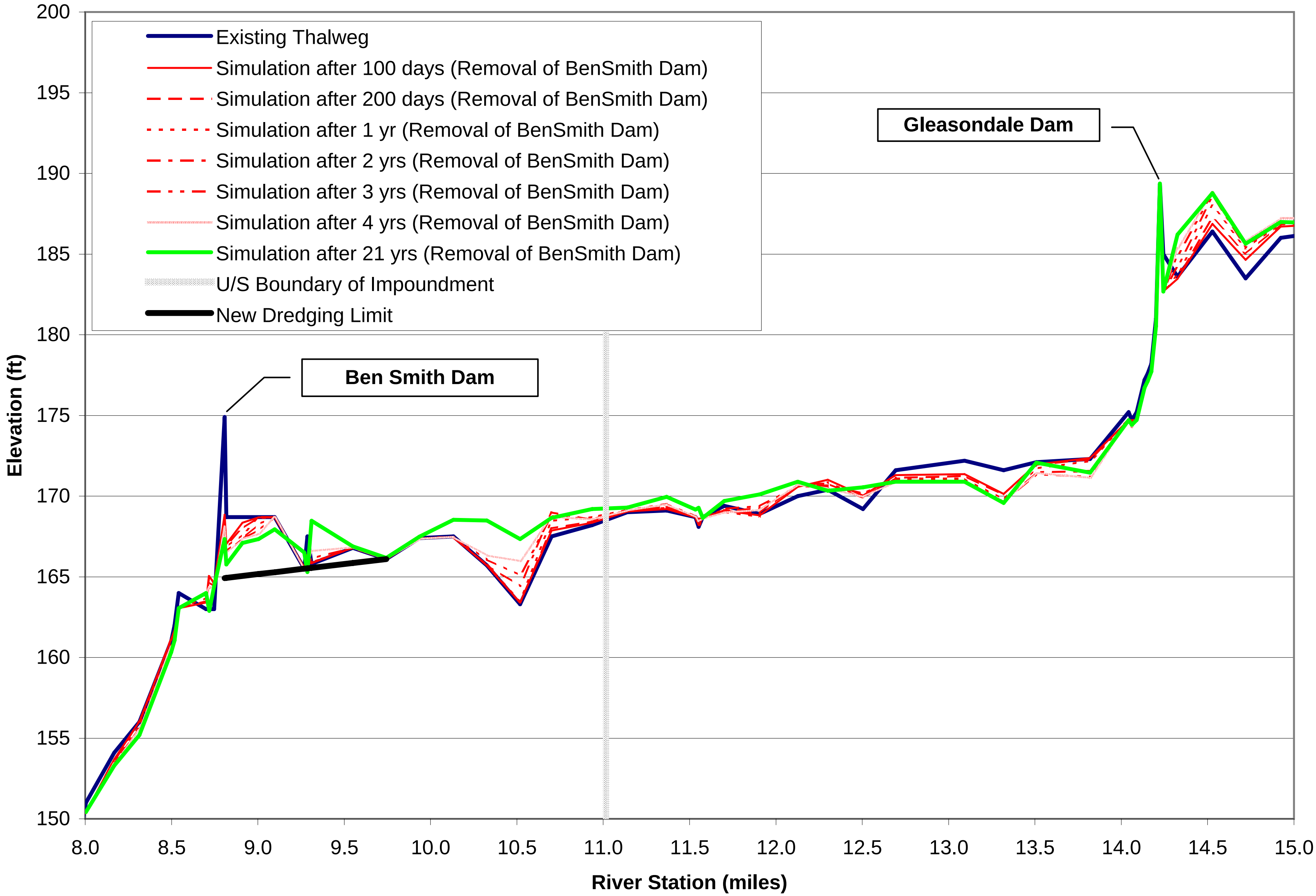
Existing Thalweg
Simulation after 100 days (Removal of 3 Dams)
Simulation after 200 days (Removal of 3 Dams)
Simulation after 1 yr (Removal of 3 Dams)
Simulation after 2 yrs (Removal of 3 Dams)
Simulation after 3 yrs (Removal of 3 Dams)
Simulation after 4 yrs (Removal of 3 Dams)
Simulation after 21 yrs (Removal of 3 Dams)
U/S Boundary of Impoundment
New Dredging Limit
Hudson (Rt 85) Dam
Gleasondale Dam
Elevation (ft)
220
215
210
205
200
195
190
185
180
175
170
14.0
14.2
14.4
14.6
14.8
15.0
15.2
15.4
15.6
15.8
16.0
16.2
16.4
16.6
16.8
17.0
17.2
17.4
17.6
17.8
18.0
River Station (miles)

Figure 4



Existing Thalweg
Simulation after 100 days (Removal of 3 Dams)
Simulation after 200 days (Removal of 3 Dams)
Simulation after 1 yr (Removal of 3 Dams)
Simulation after 2 yrs (Removal of 3 Dams)
Simulation after 3 yrs (Removal of 3 Dams)
Simulation after 4 yrs (Removal of 3 Dams)
Simulation after 21 yrs (Removal of 3 Dams)
U/S Boundary of Impoundment
New Dredging Limit
Gleasondale Dam
Elevation (ft)
220
215
210
205
200
195
190
185
180
175
170
14.0
14.2
14.4
14.6
14.8
15.0
15.2
15.4
15.6
River Station (miles)

Figure 5



Existing Thalweg
Simulation after 100 days (Removal of BenSmith Dam)
Simulation after 200 days (Removal of BenSmith Dam)
Simulation after 1 yr (Removal of BenSmith Dam)
Simulation after 2 yrs (Removal of BenSmith Dam)
Simulation after 3 yrs (Removal of BenSmith Dam)
Simulation after 4 yrs (Removal of BenSmith Dam)
Simulation after 21 yrs (Removal of BenSmith Dam)
U/S Boundary of Impoundment
New Dredging Limit
Gleasondale Dam
Ben Smith Dam
Elevation (ft)
River Station (miles)
200
195
190
185
180
175
170
165
160
155
150
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
15.0

Figure 6

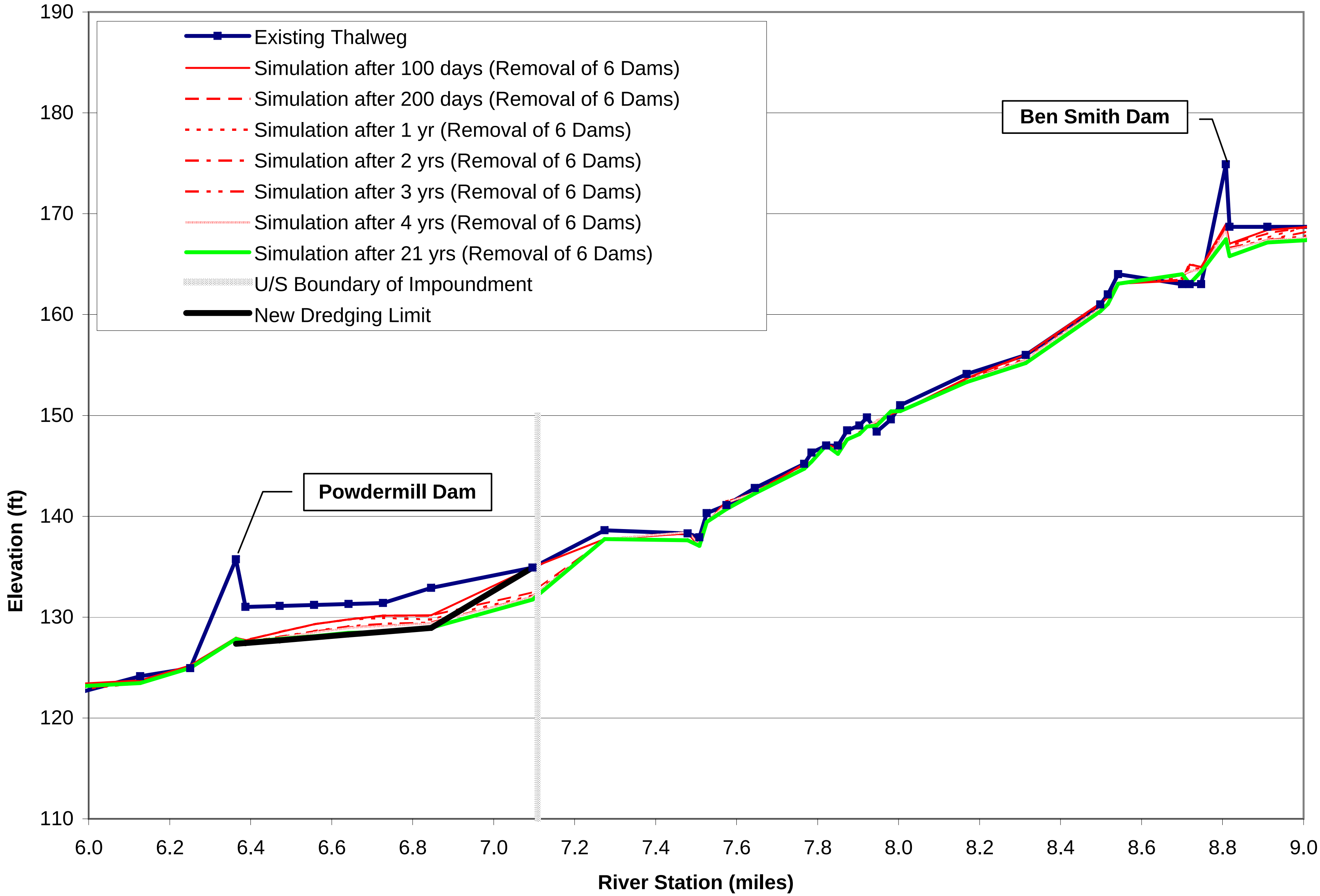
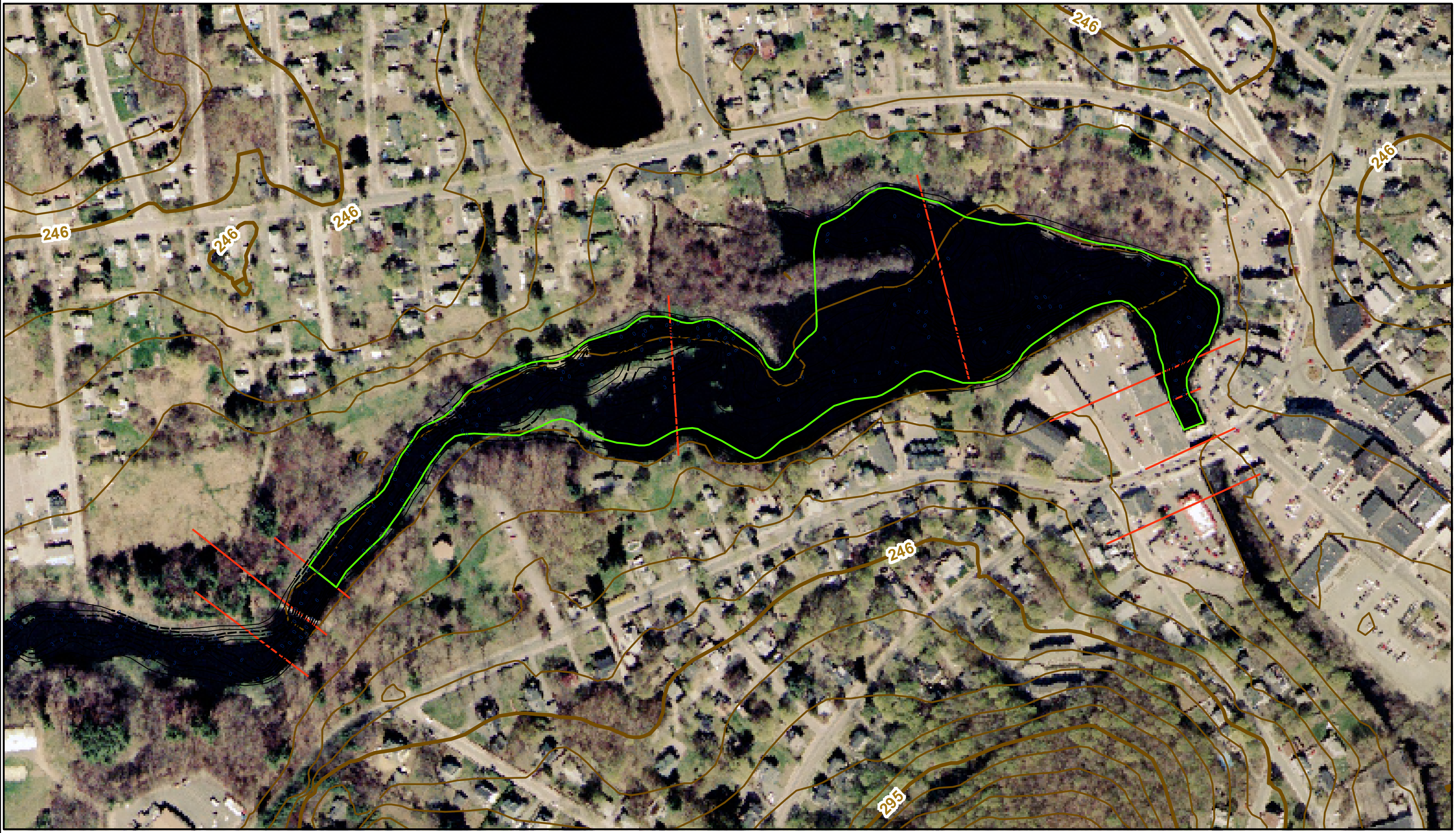

Existing Thalweg
Simulation after 100 days (Removal of 6 Dams)
Simulation after 200 days (Removal of 6 Dams)
Simulation after 1 yr (Removal of 6 Dams)
Simulation after 2 yrs (Removal of 6 Dams)
Simulation after 3 yrs (Removal of 6 Dams)
Simulation after 4 yrs (Removal of 6 Dams)
Simulation after 21 yrs (Removal of 6 Dams)
U/S Boundary of Impoundment
New Dredging Limit
Ben Smith Dam
Powdermill Dam
Elevation (ft)
190
180
170
160
150
140
130
120
110
6.0
6.2
6.4
6.6
6.8
7.0
7.2
7.4
7.6
7.8
8.0
8.2
8.4
8.6
8.8
9.0
River Station (miles)

Figure 7



Assabet River - Hudson Dam

CDM

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Dredging Extent
1 ft. bathymetric contours
3 ft. bathymetric contours
9 ft. contours
49 ft. contours

Data Sources:
MassGIS, USGS, USACE,
Normandeau Associates

1 inch equals 336 feet

Map Scale: 1:4,031

0 95 190 380 Feet

Assabet River - Gleasondale Dam

CDM

Dredging Extent

9 ft. contours

49 ft. contours

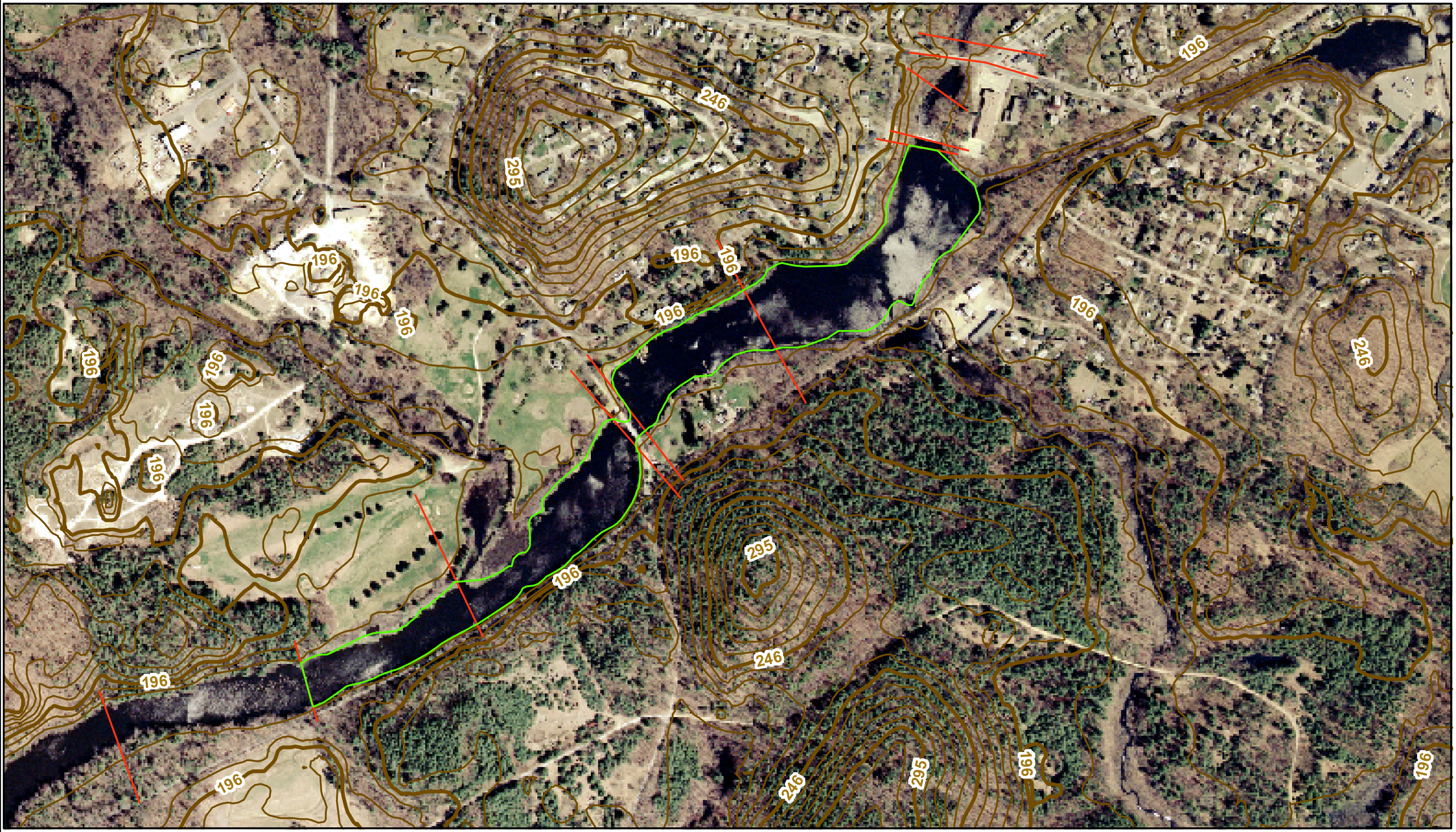
Data Sources:
MassGIS, USGS, USACE,
Normandeau Associates

1 inch equals 267 feet

Map Scale: 1:3,204

0 40 80 160 Feet

\\CAMDFGM2P31\JProjects\Projects\Assabet_river\newMXDs\OrthoMXDs EMW 01/2008



Assabet River - Ben Smith Dam and Dredging Extent

CDM

\\CDMD\FT681C1\JProjects\GIS\AssabetRiver\GIS\newMXDs\Dredge_BenSmithDam.mxd JFP 01/2008

Dredging Extent
9 ft. contours
49 ft. contours

Data Sources:
MassGIS, USGS, USACE, Normandeau Associates

1 inch equals 710 feet

Map Scale: 1:8,524

0 195 390 780 Feet

Attachment 4

CDM Response to Mass DEP Comments on the Draft Sediment Management Plan

USACE Assabet River Sediment and Dam Removal Study
Sediment Management Plan
DEP Comments and CDM Responses
November 2008

DEP Comment	CDM Response
Page 2-1, second to last paragraph. The February 13, 2008 CDM Memorandum regarding sediment removal quantities should be included in the report as an attachment so that this detailed information is readily available.	This memo is included as Attachment 3 of the revised plan.
Page 2-2, Section 2.2.2. It is stated that the initial review indicated that there is limited potential for contamination. A brief description of what the initial review found would be helpful – e.g.: what are the past and present land use practices in the watershed?	The initial review identified waste sites located in proximity to the impoundments. Past and present land use practices will be identified through the due diligence process to be completed before initiation of the field sampling program.
Page 2-2, Section 2.2.2, last sentence. It is not clear what the MassDEP tracking list is.	The MassDEP's database of sites where a release or threat of release has been reported in accordance with 310 CMR 40.0300. A statement clarifying this list was added to the revised plan.
Page 2-4, middle of first paragraph. It is noted that there are other acceptance criteria and/or MassDEP approvals that may be required prior to disposal. Have all of these been outlined in the report? A table or chart that places all this information in one place should be added. A decision tree type graphic that summarizes what needs to be done based on findings would also be very helpful.	Noted. This requires further discussion with MassDEP as well as other regulatory agencies and disposal facilities. This effort is beyond the scope of current planning-level study, and should be addressed during future phases of the project.
It should be indicated that the USGS sampling sites referred to in Section 2 are contained in Attachment 2.	The reference was added to the revised plan.
Figure 2-3 indicates a dredging boundary that includes a peninsula of land in the upper northwest portion of Hudson Impoundment. The reasoning for dredging this particular area should be presented.	The dredging boundaries as shown are approximate and were developed based on results of the HEC-6 modeling. Further studies are required during subsequent phases of this work to determine actual dredging boundaries.

DEP Comment	CDM Response
Figure 2.4 indicates a considerable upland/wetland area in Gleasondale Impoundment that may have to be dredged. The reasoning for dredging this particular area should be presented and clarification should be made that any dredging would have to go through normal permitting processes such as MEPA and the Wetland's Protection Act to achieve final approval.	The dredging boundaries as shown are approximate and were developed based on results of the HEC-6 modeling. Further studies are required during subsequent phases of this work to determine actual dredging boundaries.
It would be helpful if the summary USGS sediment data tables in Section 2 were flagged somehow to indicate when parameters were over the threshold limits.	The parameters that were above the threshold are highlighted in the revised plan. However, it should be noted that the testing of the dewatered and processed sediment may not show similar results.
For comparison purposes, it would be helpful if at the end of Section 2 a summary table of all the impoundments was provided that indicated which parameters exceeded the Category RCS-1 and Landfill reuse criteria.	A summary table of each of the impoundments (Table 2-X) was added to the revised plan for comparison purposes, however as stated previously testing of the dewatered and processed sediment may not show similar results.
Page 3-3, fourth paragraph. It is stated that water samples will be collected at three locations in each impoundment. What parameters should be analyzed and where in the impoundment should the sampling sites be located (inlet, outlet, center?).	The three water samples should be collected at the inlet, outlet, and center of each impoundment and then composited. The objective is to use the site waters and site sediments when performing the chemical conditioning program, so that the reactions with the polymers or alums during bench scale testing will be representative. If needed, can analyze the composited water sample for chemicals of concern (COCs) that would need to be addressed for water treatment. Effluent samples coming out of the hanging bag tests during the sediment dewatering study should also be tested for water treatment COCs. Text has been added to Section 3.2 explaining the purpose of water samples.

DEP Comment	CDM Response
Table 3-2. What procedure will be used to determine which sediment cores will be selected for analytical testing?	Visual observations in the field.
Table 3-2. This table indicates that in Ben Smith Impoundment there are 18 sediment core locations for geotechnical testing. Figure 3.5 indicates an additional 12 sites that are outside of the dredging area. An explanation should be given for why these sites are being presented.	The figure is incorrect and the additional 12 locations will be removed.
Section 5.2.2 Dewatering. Besides obtaining permission from the landowner, are there any other issues that should be considered with the proposed dewatering sites?	Technical considerations include assessing the topography, existing site features, proposed traffic patterns, subsurface ground conditions, and groundwater levels at each proposed dewatering site. These considerations are related to site preparation of the laydown area station described in Section 5.2.2 and includes areas for desanding, dewatering, solidification, water treatment, and loading operations. Prior to preparing the dewatering sites, will need to determine if any facilities need to be removed, wells need to be abandoned. Removal of buildings may include demolition, removal of demolition debris, lead paint and asbestos surveying, re-routing or abandonment of utilities. The dewatering sites should be relatively flat and dry and have sufficient bearing capacity to support construction equipment, truck traffic, materials, the geotubes filled to capacity, and piles of sediment. If the dewatering site contains organic material or soft soils, the soils may need to be stripped or excavated and replaced with a suitable subgrade material. A work pad may need to be constructed to provide adequate support. Subsurface investigations should be performed to assess the conditions at the dewatering sites.

Section 5.2.2 Dewatering. Besides obtaining permission from the landowner, are there any other issues that should be considered with the proposed dewatering sites? CONTINUED…	Additionally, traffic patterns should be established so that trucks can be loaded and unloaded efficiently. Non-technical considerations may include permitting issues, construction noise levels and possible odor concerns with the sediments. Odor concerns may be addressed by covering stockpiles with poly or a foam, if needed. Text has been added to Section 5.2.2 explaining the considerations for identifying dewatering sites.
Table 5-5. For the Allen Street Impoundment, under general notes add that Site 2 is smaller than the estimated required area for dewatering.	This note will be added.
Table 5-7. It is not clear what the terms Mob/Demob mean.	Mobilization and Demobilization of construction equipment required for dredging and dewatering operations. A footnote was added to Table 5-7 in the revised report.
Has any analysis been done on how the bathymetric contours of the impoundments will change with dredging? How deep will the dredged impoundments be? This information, if available, would be good to include in the report.	No analysis has been conducted to date. This is beyond the scope of the current planning-level study.
Preliminary cost estimates for the proposed dredging and disposal should be provided either in this document or another chapter.	Planning-level cost estimates were provided to USACE as a separate deliverable.